Thesis Title: Language and Cultural Barriers in Planning Communication

Senior Honors Thesis City & Regional Planning

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by

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TABLE OF CONTENTS

I. Abstract 4
II. Introduction 6
III. Literature Review 9
    A. Planning Process and Public Participation 9
    B. Cross Cultural Communication 14
    C. Tools Used Today in Planning 19
    D. Conclusion 21
IV. Methodology 22
    A. Research Design 22
    B. Population and Sampling 24
    C. Timing and Compensation 25
    D. The Experiment 25
    E. Data Processing 42
V. Results 43
    A. Descriptive Analysis 43
    B. Correlations 47
    C. Repeated Measure Analysis 49
VI. Discussion 53
VII. Conclusion 55
Work Cited 58
Appendix A 60
Appendix B 67
Appendix C 68
Appendix D 71
Appendix E 72

I. Abstract

English is considered one of the international languages. Although, there are more than 6,170 living languages in the world and most of them are spoken in Africa or Asia. When English is a second language, is its use enough to communicate technical information? Although all parties may speak English, some may not understand it as well as others. Additionally, any information may be viewed through a cultural lens. Through the study of critical theory, communication theory in planning and cross cultural communication tools used today, this research seeks to test, in a context where English is the common language among non-native speakers, which forms of communication - visual or verbal - will improve the understanding of a planning technique. The Solomon Four Group experimental design is used to test how well each subject performed in a series of four tasks. The four tasks were given in a randomized order in

the experiment: two planning related and two non-planning related. The planning-related tasks included 1) creating a building parcel from given form-based codes and 2) creating a building structure from given form based codes. The non-planning related tasks included 1) an assembling task and 2) folding an origami. The experiment tracked the amount of time it took to complete each task and the accuracy of each step in each task. The experiment showed that learning and understanding the same amount of information when given in the same context varies. The results of this experiment suggest that visualization can provide the audience with a strong and comprehensible idea of the proposed plan, whether native or non-native English speakers. These results help further the optimization of communication of planning techniques between two parties of different English abilities and cultures. This study provides support for the use of visual communication techniques rather than the traditional use of translators when working in English in countries whose native language is not English.

II. Introduction

Can visualization techniques to overcome language and cultural barriers be used to help communicate planning concepts? To answer this thesis question, several aspects of planning theory and communication need to be considered. The four main topics are as follow, critical theory, communication theory in planning, and cross cultural communication and the tools used today. These perspectives are important because they tell us why planning is useful, how it's used, and how its knowledge is being transferred. From this research, we can see what kinds of communication has worked and has not worked and improve upon it.

The Oxford Dictionary defines language as the system of human communication, either written or verbal, used by a particular community or country in a structured and conventional way. English might be rapidly spreading across the world, but English as second language

speakers are not as proficient as native speakers. Even when communicating in the same language, the terminology used in a message may act as a barrier if it is not fully understood by the receiver. When people talk about the use of English as a language for cross cultural communication, the question that should arise most importantly is how can we insure mutual intelligibility among speakers from different cultures? When transferring innovative planning techniques from a developed to a developing country, English is not the first language of many involved. Their use of the language may be peppered with culture-specific or non-standard English phrase, which can hamper the communication process and it can be difficult at times to communicate effectively with individuals who speak another language.

Native English speakers take for granted that their language might be one of the most well known. However, the developing countries contain most of the world's 6,170 living languages. More than 60 percent of these languages are spoken in Africa and Asia (Grimes). Even for native English speakers, cross cultural communication can be an issue, such as people in different states and even married couples, as can be seen later. Cultural differences should be considered in an effort to optimize communications between two parties.

This thesis is motivated by my concern about Ghanaians residing in the Offinso North District Ghanaians residing in the Offinso North District. In May 2013, I traveled to Ghana with a group of The Ohio State University students to implement 8 development projects. My role was to create a technical manual for implementing sustainable and innovative development for the Offinso North District in the Ashanti region. In the meeting with the district's masons, communication between the 25 of them and the 4 of us was through a translator for 4+ hours. This interaction was what brought my attention to the problems of communicating through

language and cultural barriers even through a country whose official language is the same as ours. Were the planning techniques I was suggesting fully understood? Do they have words that mean the same as our terminology? Were they already using these techniques? Is our translator completely informing the two different groups exactly what we said to each other? How can we use visual communication to overcome language and culture barriers to broaden the knowledge of planning techniques thoroughly?

Before these questions can be fully understood and addressed, more needs to be known about the differences between offering people visual versus verbal instructions to complete tasks as they relate to planning. Do native speakers and non-native speakers of English learn and understand the same amount of information when given in the same context? This thesis is a step towards understanding the importance of visual and verbal instructions with the context of urban planning. My research questions are: 1) Is there a difference in our ability to understand planning concepts when given visual compared to verbal instructions? 2) Are planning concepts easy to understand regardless of whether or not they are explained using visual versus verbal techniques? Following this research, a form of communication should be discovered to better improve the understanding of a planning technique told through language and cultural barriers.

III. A Planning Literature

A. Planning Process and Public Participation

Critical theory and communication theory lead to understanding about the planning world today and why communicating through language and cultural barriers is so important when the public realm is involved. Habermas's communication theory can also be referred to as communicative rationality (Habermas, 1989). This theory is about reaching a consensus through deliberations involving all stakeholders who need to hear each other correctly. Habermas argues that trust relations between the communicating parties is crucial. If there is no trust or respect, ideas will not be transferred fully from one party to another even though they use the same language and are from the same culture. Consensus building emerged parallel to this theory. The only difference is that Communicative rationality consists of a group of chosen individuals to

represent all differing stakes in a problem (Innes 1996). For both, participants have access to all common information and all concerns are heard.

In consensus building, differences of interest and value are essential. The differences between dialogue, debate and negotiation is what makes up the public deliberations. John Forester considers 3 central points: integrating public participation with innovative and effective negotiation, treating public participation for meaning and argument, and understanding democratic participation and public deliberation (Forrester, 2006). Without different interest, problems would not be brought up, argued over and solved for the better of the community. Planning for public participation has to do with not just discussions and promises of investing in new plans, but also in the commitment to do the right things. For facilitating a public meeting, we have to seek to understand knowledge of each other, to establish or refute an argument and to agree upon a course of action. For the best possible result, this has to be done for collaborative change. Planning can have an important effect on shaping and reshaping ethnic and cultural identities.

Sometimes ideas or meaning appropriate at a certain time are no longer relevant for the new generation of social circumstances. Throughout recent history, signs of alternative conceptions of planning proposed and practices can be increasingly identified and debated in planning theory (Habermas, 1989). The effort of constructing mutual understanding as the focus of reasoning activity replaces the subject centered philosophy of consciousness, which Habermas argues has dominated Western conceptions of reason since the Enlightenment.

Planning is concerned with the management of change from above (Friedman, 1987). Take social reformers, as an example. To implement reforms like civil rights or women's

liberation, it had to be done through the state. Yet both were initiated through grassroots mobilization. The movement from the bottom forced the state to confront it and later changed these social inequality problems. The modern approach of planning is not to address a predefined set of tasks but to discover, learn, and understand problems through inter-communicative processes. Communication must be through exchanging perceptions and understanding, drawing through life experience, cultural and moral knowledge available to participants even through both language and cultural differences.

Since planning is a public decision making domain sanctioned by the state, planning needs to avoid exclusion of various groups from meaningful participation in decision-making (Yiftchel, 1984). According to Oren Yiftchel, planning can be a form of control imposing decisions from above through sophisticated methods of information distortion and meaningless methods of public consultation. Treating planning as a communicative enterprise promises to bring a democratic way of policymaking to society (Healey, 2008). There is the belief that a dialogue-based form of planning could be a critical arena for officials to invent and test different democratic structures. However, when it comes to communicating with non-native English speakers, how does one know they are transferring their knowledge fully? More so, when the power relations are not symmetric, or the system of decision making is non-democratic, how could we implement a dialogue-based planning discourse? When opinions are not expressed through a voting system, it does not necessarily mean that we are dealing with an authoritarian regime. Concerns and ideas might have been channeled to community leaders informally who will then make a decision.

The Dark Side of Planning

With the emergence of planning in the public realm and public participation being encouraged, it is advisable to look at the underside of planning. According to Yiftchel, planning's emergence was intimately linked to a broader reform movement that sought to redress the ills of constrained capitalism through changes to the politics, economy, and geography of cities (Yiftchel, 1998). Planning is associated with improving people's physical living conditions in the city, region and or society.

A central component of the nation-state order is the development, maintenance, and reproduction of national and ethnic identities (Yiftachel, 1998). However, this is usually only representative of the wealthy, at the expense of everyone else. Therefore, a planner has impact on the cultural dimension and collective identities within the existing city and state by encouraging public participation. Linking planning to the state provides planning's legitimacy and power, however, that usually means advancing the interests of social elites and dominant groups at the expense of weaker groups.

The conceptualization of planning gives rise to a paradox because the very same tools used to assist social reform and improve people's quality of life can be used to control and repress peripheral groups. Widening our understanding of planning as a double edged sword that uses its principles and tools in either a regressive or progressive way is encouraged (Yiftchel, 1998).

According to Taylor and Mitchell's work on political-geographical framework and organizational analysis, planning is oppressive and marginalizes elements of society that threaten to destabilize the capitalist order (Yiftchel, 1998). This is believed so because planning was

sanctioned, empowered, and implemented by the state, which is a web of institutions imposed by the elite. The role of planners is not just as professionals but also as citizen within the apparatus of control in a public decision making domain that is sanctioned by the state.

Communicative theory in planning can lead to some understanding of why communication through language and cultural barriers can be so important when it comes to the planning world. Pragmatists argue that when confronted with new ideas, frames of reference or evidence that challenges what we had previously believed, the critical questions to address are what difference does it make and what does it imply for us here and now? Social and natural sciences provide rich resources to enlarge the understandings and claims that are available in specific situations to help in molding how a policy comes to address the challenges it faces (Healey, 2008).

Hilda Blanco (1994) argues that if planning is understood as "a process of imbuing vague and general public goals or objectives with specific meanings," then "public planning" makes a contribution by "developing a public language that could reanimate a meaningful public realm" (Blanco, 1994). According to Healey (2008), the challenge of thinking through how to realize the potential of the planning project for a more widespread opportunity for human begins to flourish in a more sustainable world should be considered the most significant for shaping future opportunities and releasing future potentialities.

Planners themselves are assumed to be people of goodwill who worry about ethics, inclusion, and equality and are blessed with unusual reflexivity and insight into the constraints on their own and other people's understanding and actions (Huxley, 2000). They are unlike bureaucrats who are accountable to elected representatives and not directly to the public. For

Habermas, deliberation in the public sphere cannot be sponsored by the decision making of the state but instead the public.

Communicative planning literature often suggests communication can result in a consensus based on agreement (Huxley, 2000). However, there is the issue of communicating in the face of language and cultural barriers and not meeting the ideal speech situation (Habermas 1989). Planners can observe and discover current issues to address with the participation of the public sphere but certain ideas or meanings are understood differently to different people.

B. Cross Cultural Communication

According to Edelman, "the use of political language is a clue to the speaker's view of reality at the time, just as an audience's interpretation of the same language is a clue to what may be a different reality for them" (Fischer, 2003). The ideologies and values underlying policies are often reflected in symbols. Created through language and communicative interaction, such symbols signify the meanings of particular events and offer standards for judging what is good and bad (Fischer, 2003). Symbols and multiple meanings create problems that are inherently laden in everyday life. Different interpretation reflects the diversity of the audience and the language to which they are exposed.

Using the example of politics, the creation of meaning is basic to the mobilization of support for particular actions or efforts to immobilize the political opposition through the construction of beliefs about events, policies, leaders, problems, and crises. It is a crucial dimension that rationalizes and challenges existing inequalities. According to Frank Fischer (2003), many ideas and beliefs have the impression of being natural and obvious in the language

of the everyday world. For example, it is common today in the Western world to accept women as equals to men with the same rights. But, as feminists would point out, multiple laws and practices still exist and originated from the time when women were seen as inferior. Cultural barriers can happen simply between generations; as human beings have grown, values and meanings change.

Understanding cross cultural communication is a means to understand language and how to improve problems facing the world and the people in it, such as the task of teaching. A couple of levels of differences in cross cultural communication include: when to talk, what to say, pacing and pausing, listenership, intonation and indirectness (Tannen, 1984). These do not only describe the ways that meaning is communicated in conversations but also how one identifies with his or her social network.

Things as simple as asking questions, offering advice and information or exchanging compliments between cultures can be interpreted differently, either for better or worse. Alaskan Athabaskans – a group of related North American Indian languages including the Apachean languages and languages of Alaska, northwest Canada, and coastal Oregon and California – regard questions as too powerful to use because they demand a response (Scollon, 1982). Many in the United States take for granted that questions are basic to the educational settings or the use of jokes, irony and sarcasm in conversations. Humor in one culture can be seen as offensive in another.

According to Tannen (1984), a universal way of communication is telling stories. However, stories are just one of a range of conversational acts which seem obviously appropriate to the speaker but not the listener of a different cultural background. Members of a Jewish

background were found in a research study by Tannen to be more likely to tell stories about their personal experiences, while those with a non-Jewish background tended to talk about events that happened to them without the input of their feelings (Tannen, 1984). As a result, members of each group often responded to each other's stories with subtle signs of impatience.

People in different communities have different ways of using linguistic means to communicate. Their way of talking defines them as a community thus communication is very culturally relative. The range of aspects of communication can vary from culture to culture. In the most general level, the question of when to talk is culturally relative. According to Tannen, and Saville-Troike, cultures differ with respect to what is perceived as silence and when it is deemed appropriate (Tannen and Saville-Troike, 1985).

The example they used was that Athabaskan Indians consider it inappropriate to talk to strangers until they know each other but non-Athabaskans want to get to know the other by talking. This could lead to differing cultural views of each other: the Athabaskans having stereotypes of non-Athabaskans as hypocritical because they act as if they are your friend when they are not, and the non-Athabaskans having stereotypes of the Athabaskans as sullen, uncooperative and even stupid. This can even be seen within a single country like the United States between New Yorkers and non-New Yorkers.

Non-Verbal Communication

Some of the most visible nonverbal communication mechanisms are pacing, processing and pausing. Differences in expectations about these matters can bring a conversation to an end. The example used was that the British would wait for a pause in the conversation to take their

turn while Americans would perceive that pause as an uncomfortable silence in which to fill (Tannen, 1984). Even being married is no proof against mutual misinterpretation. Slower talking partners could accuse the faster one of not giving them a chance to talk or not being interested in what they have to say while the faster partner could accuse the slower one of not talking to them or saying what is on their minds.

Gaze and listenership is another example of nonverbal communication. Erickson and Shultz found that Caucasian participants in counseling interviews maintained eye contact when listening and frequently broke their gaze when speaking while the African Americans did the opposite. To those unacquainted with this knowledge, the Caucasian speaker might feel the listeners weren't paying attention because the expected sign of attention was a steady gaze. Thinking their listeners was not paying attention, they might repeat what they were saying in simpler terms, making the listener feel like they were being talked down to.

Intonation is made up of degrees and shifts in pitch, loudness, and rhythm. A pause in the wrong place, or an intonation misunderstood can cause a whole conversation to go awry. An example from Gumperz is the way the word, gravy, was spoken to customers coming through the cafeteria line in London's Heathrow Airport (Tannen, 1984). The Asian workers complained of discrimination when the customers who ate in that cafeteria complained of rudeness by the Asian employees but not the British employees. What was discovered was the differing intonation in which the two different groups spoke; the British employees spoke the word gravy with a rise in the intonation as a question while the Asian employees' intonations fell at the end turning the word gravy to a statement as in take it or leave it. Tiny differences in intonation can throw an interaction completely off without the speakers knowing what caused the problem.

One might think knowing each other a long time would lead to mutual understanding but reactions to and interpretations of subtle signals are automatic. How you are raised and the community you grew up in are both associated to each other, forming a person's cultural identity. Everyone knows body posture and movement communicate. Standing face to face or leaning forward may show that we are relaxed. Tapping on the table or playing with coins mean we are nervous. Motioning someone to come closer means we want to talk to him or her. Posture offers insight into a culture's structure; in many Asian cultures, bowing is much more than a greeting, it signifies status and rank (Wang, 2009). For example, lower posture in Japan is an indicator of respect. When participants are of equal rank, they begin and end the bow in the same manner.

The largest part of communication is made up from hints, assumptions and the listener filling in from context and prior experience. Americans as a group tend to ignore indirectness; we believe that words should say what they mean and people should be accountable only for what they say in words (Tannen, 1984). This can be seen when American businessmen try to skip the small talk and get right down to business as opposed to the Japanese, Arab, or Mediterranean businessmen where elaborate small talks are essential to the foundation of their business dealings. In a study comparing Arabic and English cultural structure, Barbara Koch shows that argumentation in Arabic is highlighted by saying over and over the important points rather than building up to the point (Koch, 1893). To Americans such repetitions seem pointless and not dramatic.

In recent years, the use of nonverbal communication methods experienced some new developments. For instance, with the rapid expansion of the Internet, it is now common to chat with another person on the Internet from different parts and culture of the world (Wang, 2009).

If we want to tell the person we are happy, we can send an emotion picture with a smiling face and the person will understand your mood easier than with just characters. Language is just another from of symbols. Nowadays, people often feel unsatisfied with or unable to use language as a communication method, so we often seek the help of various signs and symbols, which can transfer knowledge more directly, effectively and rapidly.

C. Tools Used Today in Planning

Visualization can provide the public and decision makers an instantly clear and understandable idea of the proposed policies and plans. Graphics such as icons and logos provide a familiar image to the audience that promotes a point while creating instant recognition. There are not many examples of tools used today in planning for cross communication between languages and cultural barriers. However, listed below are a few examples.

The Federal Highway Administration uses visualization in planning to strength public participation through visual imagery, complex characters of proposed transportation plans, policies and programs portrayed at appropriate scales and points of view. Examples include sketches, drawings, artist renderings, physical models and maps, simulated photos, videos, computer modeled images, Geographic Information System (GIS) based scenario planning tools, interactive GIS systems, photo manipulation and computer simulation. Visuals instead of just text blocks provides a better picture of what the planner is proposing and better understanding for those who don't have extensive knowledge in city planning.

Programs like GIS mapping provide quality data that is much more enhanced than traditional paper maps because it offers the flexibility to choose what information the creator

wants to display. GIS-based scenario planning software allows users to test alternative plans instantaneously for land use and transportation plans. Another program, visual preference surveys, can help the community and partners envision proposed plans. It is also a tool for determining the preference of a plan by the community by allowing viewers to vote on photos, renderings, maps, computer generated images, sketches or images that depict different policies.

Charrette is a collaborative session in a group of designers to draft a solution to a design problem. Somewhat like a workshop, groups are divided into sub-groups where each will work and then present their work to the full group as material for further discussion. This tool is used to integrate the interests of diversity in the group of people. Planners can use this technique as one way of engagement to acquire knowledge, such as the boundaries of a developing village, from the population.

The closest cross cultural communication tool I have come across is form based codes. Form based codes address the relationship between building facades and the public realm, the form and mass of buildings in relation to one another, and the scale and types of streets and blocks. Slowly, zoning and building codes are including diagrams and graphics with their multiple pages of text. They are also drafted to implement a community plan; the quality of development outcome depends on the quality and objectives of the involved community.

Public engagement is by definition a two way process involving interaction and listening with the goal of generating mutual benefit. As suggested above, public participation and engagement has been increasingly encouraged throughout the years because it is important for the identity of a community. Thinkers such as Jean-Jacques Rousseau suggested that participatory democracy participation in decision making increases the feeling of belonging to a

community among individual citizens (Critchley 2001).

D. Conclusion

In this day and age, good cross cultural communication and good data visualization is a must. According to Friedman (1987), the main goal of data visualization is to communicate information clearly and effectively through graphical means. Difficulties might occur at multinational meetings and translation services can be costly, hard to obtain and prone to errors. As participation in public meetings increase, differences between the native and non-native speakers may lead to differing outcomes of engagement and understanding than the facilitator wanted. For example, native speakers may learn more from discussion and dominate the conversation while the non-native speakers just listen in. As the global spread of new planning innovations continue, the application and knowledge to be transferred to developing countries must be clear and concise. Visualization may be able to overcome the lack of common language and cultural context for non-native speakers. Therefore, this research will focus on an overall question: 1) Is there a difference in our ability to understand planning concepts when given visual compared to verbal instructions? 2) Are planning concepts easy to understand regardless of whether or not they are explained using visual versus verbal techniques?

IV. Methodology

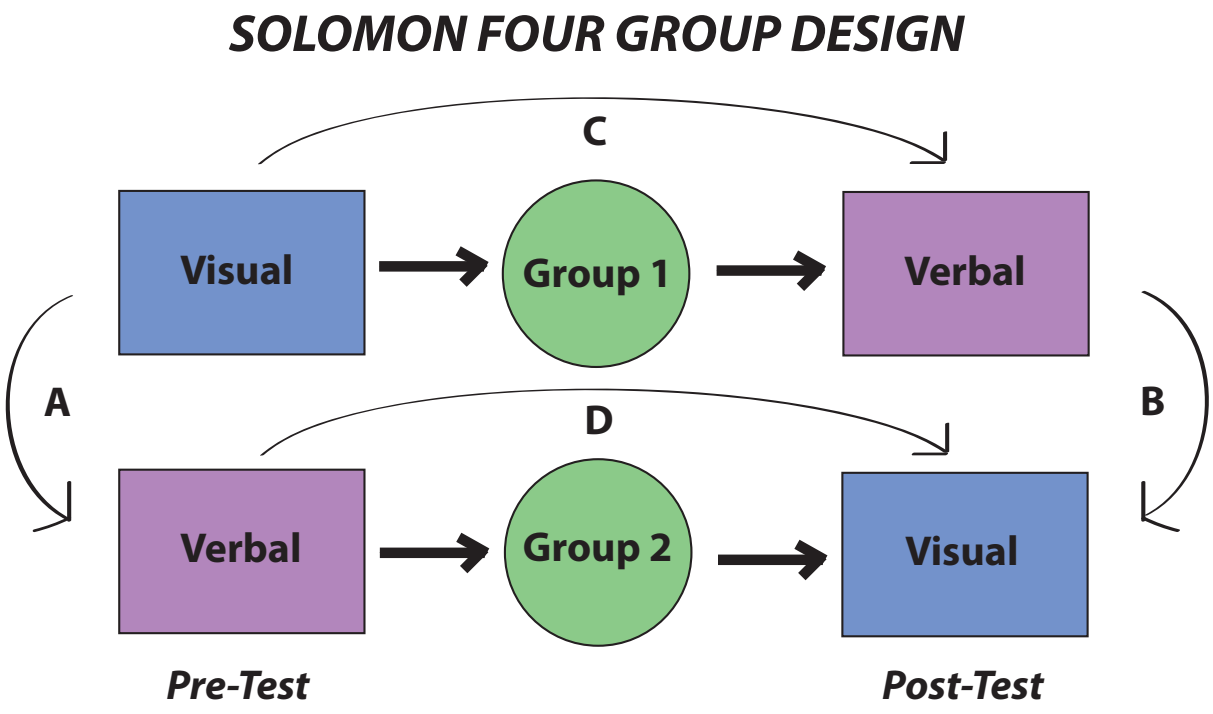
A. Research Design

This research is prompted by my interest in understanding if visual communication can help planners overcome language and cultural barriers when translating planning concepts. My research questions are: 1) Is there a difference in our ability to understand planning concepts when given visual compared to verbal instructions? 2) Are planning concepts easy to understand regardless of whether or not they are explained using visual versus verbal techniques? I wanted to test for the causal statement that visual rather than verbal communication improves our understanding of a planning proposition.

The research design involved the use of the Solomon Four Group Design, illustrated below. At label A, Groups 1 and 2 will be compared to each other after the pretest. This compares

the level of understanding between the verbal communication and the visual communication group. At B, Groups 1 and 2 will be compared to each other after both have done the pre- and post-test. Like before, this compared the level of understanding; however, Group 1 had exposure to the visual instructions before given the verbal instructions while group 2 was given verbal instructions before being exposed to the visual instructions. This compared how useful it is to have both communication techniques when transferring knowledge across culturally and between language barriers.

At C and D, both compared how their group performs during the pre-test to the post-test. Thus in group 1, the performance of the subjects with visual communication are compared to how they performed when verbal instructions were given. In group 2, the performance of the subjects with verbal instructions are compared to how they performed when visual instructions are given. An in depth analysis using this process can be seen in Appendix A. It also enables us to determine if the order of visual versus verbal instructions matter.



B. Population and Sampling

In an ideal world, I would have liked to use subjects who were from the Ghanaian community in Columbus, our Ghanaian student counterparts at KNUST or native Ghanaians, as well as running my experiments back at the Offinso North District. However, due to time and money constraints, my subjects had to be students from The Ohio State University campus.

My sample included native English speakers and non-native English speakers, as well as design oriented students and non-design oriented students. Other characteristics considered included the subject's year in school, age, ethnicity and major. I used the Solomon Four Group design (Babbie 258); thus I needed 26-30 subjects in each of my 2 test groups to see any effects between the visual and verbal communication techniques (to be discussed in the section, Experiment). This made my ideal population sample size to be 52-60 subjects. Every subject was randomly assigned into 2 groups. Group 1 pretested by performing 2 randomized tasks with visual instructions and then posttested with verbal instructions, while group 2 pretested by performing 2 randomized tasks with verbal instructions and then posttested with visual instructions. The experiment ended up with 52 subjects with 4 number of tasks completed. There was a total of 208 completed tasks. Due to time limitations, the experiments were not conducted with the ideal population size.

C. Timing and Compensation

Since there was a set time limit to put some pressure in my experiments, it took on average between 20 to 40 minutes to go through 4 experiments (5 to 8 minutes each). The debriefing took 5 minutes at maximum at which time the subject provided information about

their major, year in school, age, ethnicity, native language and how difficult they thought each task in the experiment was on the likert scale (1 = very easy to 5 = very hard). This totaled the experiment to about 45 minutes per subject at maximum.

Every subject was given the chance to fill out a slip of paper with his or her name and contact information, which was put into a drawing. The prizes included (1) $50 and (4) $10 gift cards to places such as Kroger, Chipotle, Noodles and Co. or Raising Cane's. Illustrated below is the form each subject had to fill out. The subjects rated the difficulty of the task after each completion. Then the proctor filled in the grade of each task (to be described in the section, Data Processing) and the amount of time it took to complete each task. The experiment form to be filled out by the subjects and proctor is shown in Appendix B.

D. The Experiment

In total, there were 4 different tasks in each experiment for the subject to do. Two of the tasks dealt with a planning concept while the other two did not. This way, knowledge of the planning subject and interest in the subject was randomized. Instructions were given for each of the 4 tasks, either verbally or visually. Subjects were tested on their understanding by performing the tasks they had been instructed on with a time limit. This tested the learning abilities and understanding of a concept when given through either verbal or visual communication. Verbal instructions were assigned a letter as its label while the visual instructions were given its corresponding number. Thus, the only difference between Task A and 1, B and 2, C and 3, and D and 4 are their instructions.

Tasks A, 1, B, and 2 dealt with Cincinnati's form based codes. Form based codes

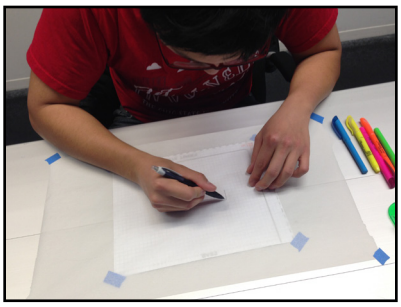
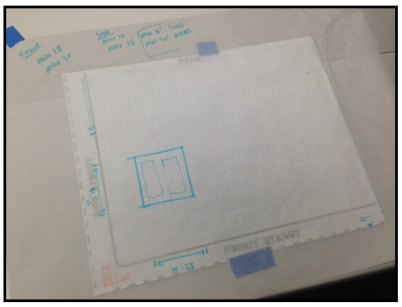
are an alternative to zoning that focuses on the form of buildings rather than land use. Four neighborhoods in Ohio, College Hill, Madisonville, Walnut Hills, and Westwood recently implemented it in 2012. The form based codes I chose for my experiment are specific to transect zones in a neighborhood with large setbacks (T5N.LS). The application of transect zones is intended to reinforce a walkable neighborhood, support serving retail and services in and adjacent to the neighborhood, and support public transportation alternative in an urban environment.

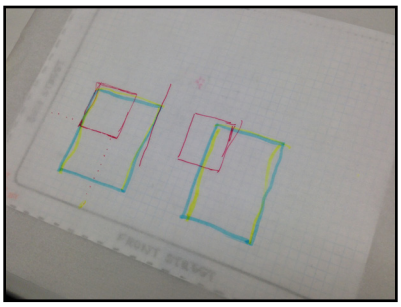
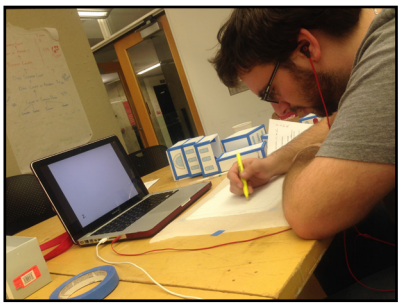
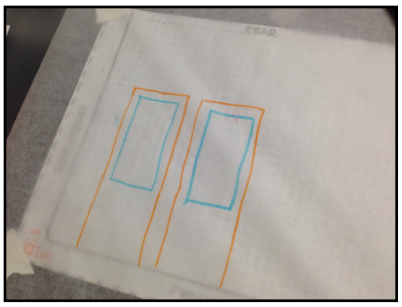
Task A & 1 specifically focused on the building site of the form based code, also known as the building parcel. The subject was given a plot of land on graph paper specifying a T5 neighborhood with a layer of trace paper and highlighters. He or she had 5-8 minutes to create a building blueprint on that site based on visual or verbal instructions. The overall instruction said: Please draw a building parcel outline for 2 houses based on the given instructions.

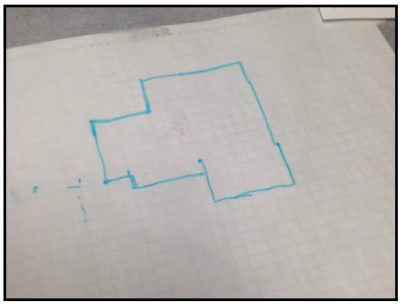
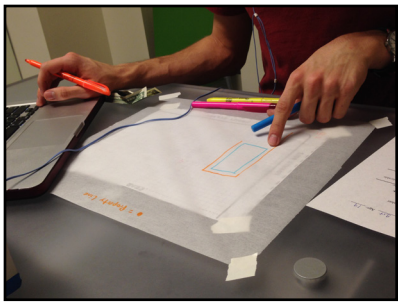
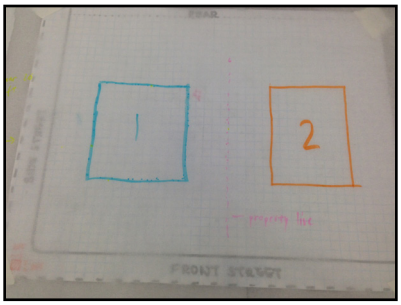
Task A – Creating a Building Parcel Verbal Instructions included:

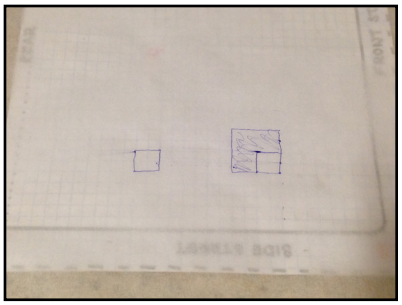
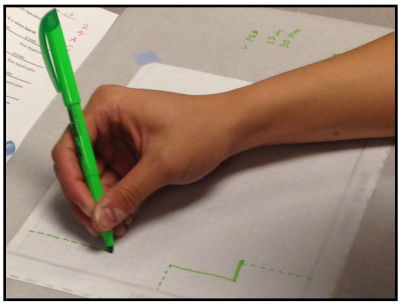
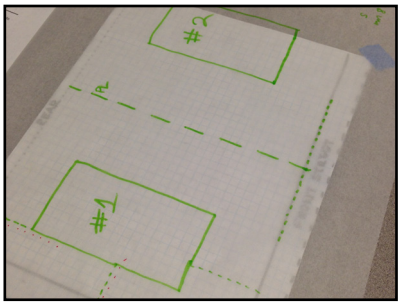
1. The front setback has a minimum of 15 feet and a maximum of 30 feet.
2. The side street setback has a minimum of 10 feet and a maximum of 25 feet.
3. The side has a minimum of 8 feet to the property line.
4. The rear has a minimum of 20 feet to the property line.

Shown below are images taken during this task performance:

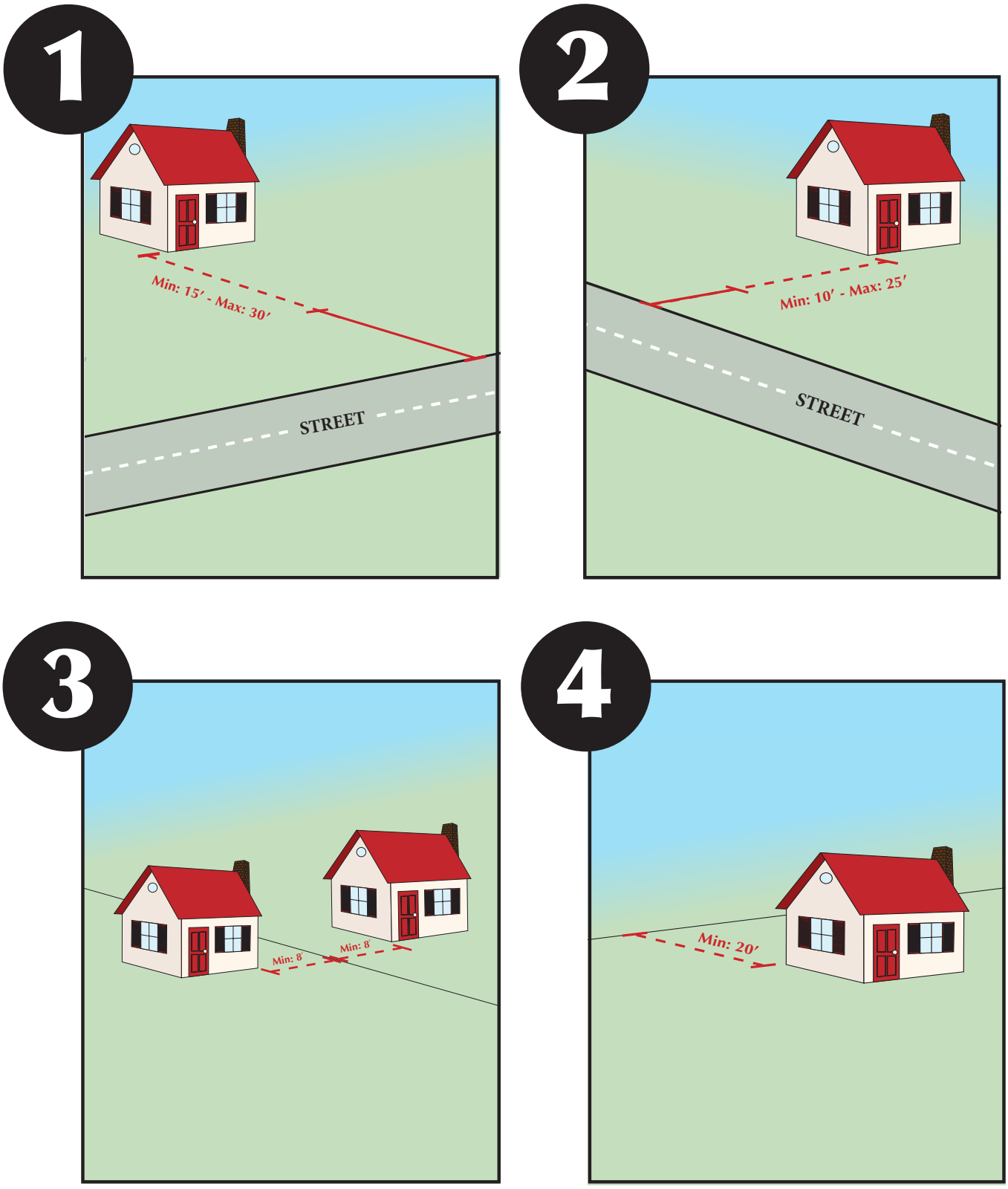



Task 1 – Creating a Building Parcel Visual Instruction is shown below:



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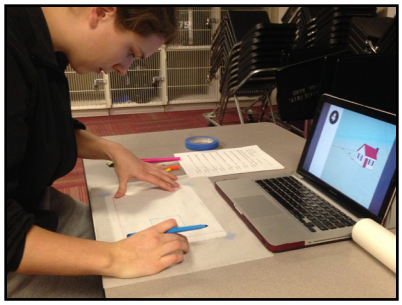
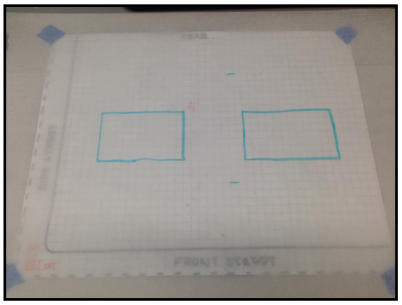
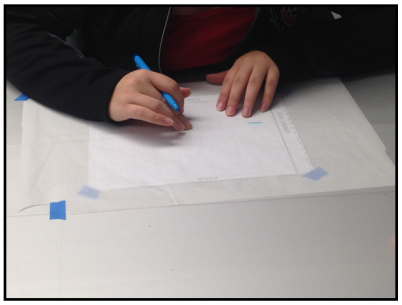
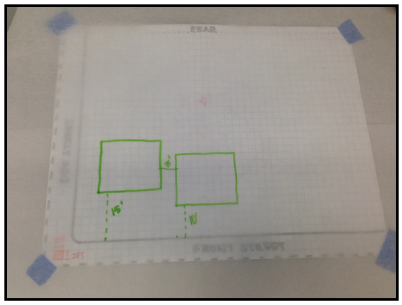
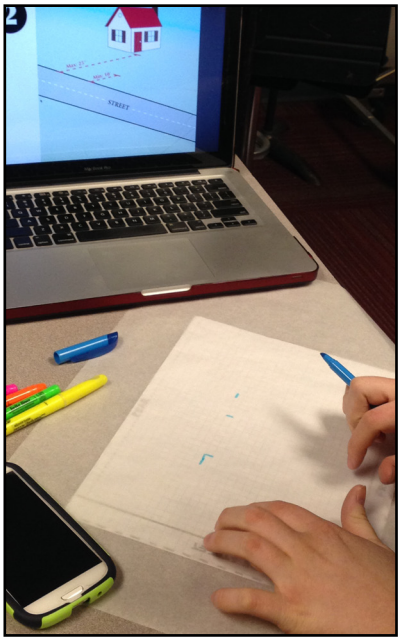
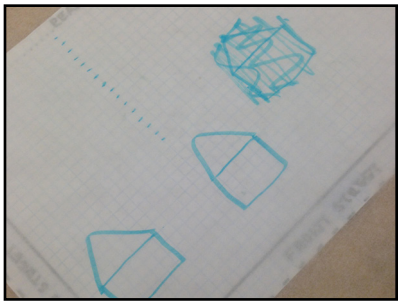
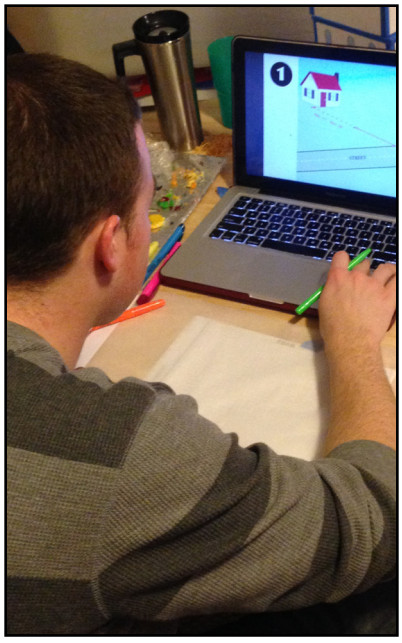
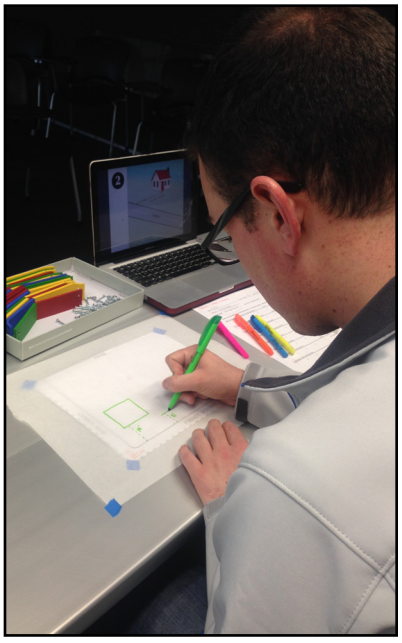
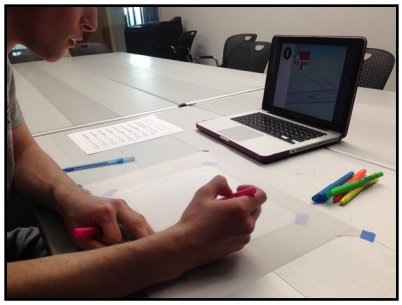
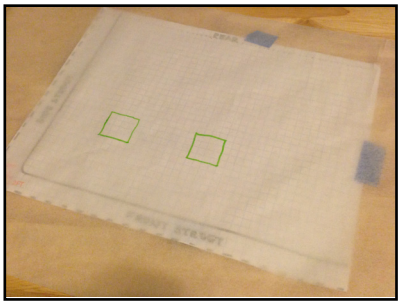








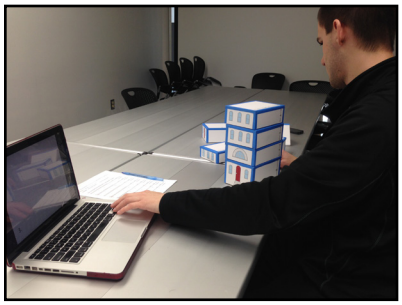




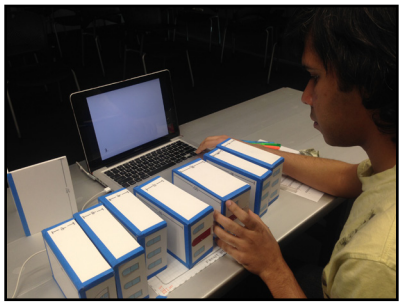
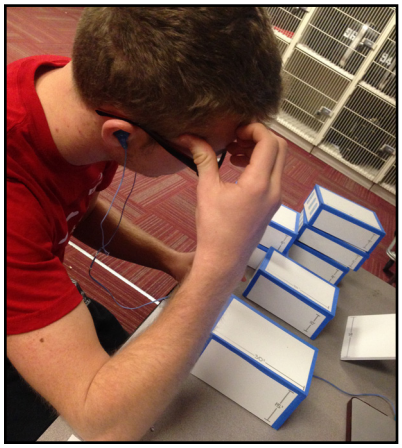
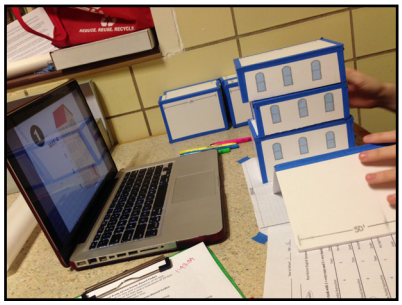

Task B & 2 specifically focused on the building form of the form based codes, also known as the building structure. The subject was given a bunch of building blocks made out of foam core boards with dimensions labeled. He or she had 5-8 minutes to create a retail building based on visual or verbal instructions. The overall instructions said: Please create a unit structure based on the given building blocks and instructions.

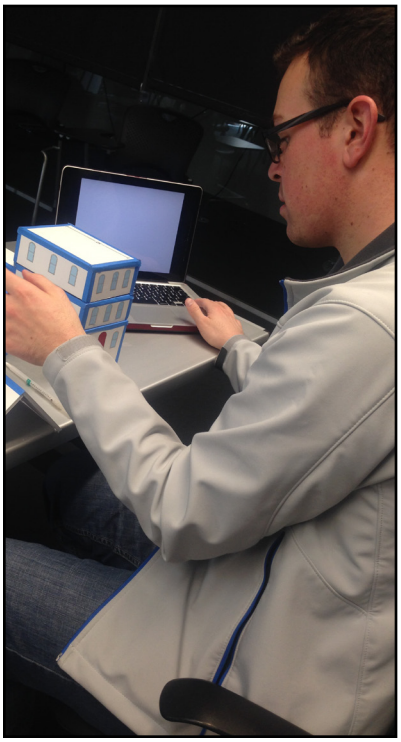
Task B – Creating a Building Structure Verbal Instructions included:

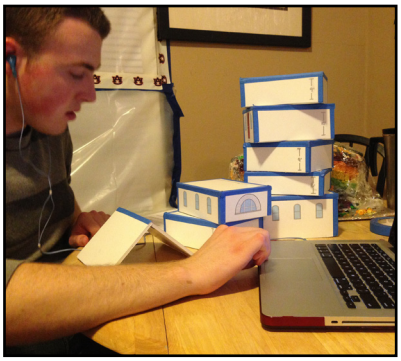
1. The building has a maximum of 4 stories.
2. The ground floor ceiling has a 14 foot minimum from floor to ceiling.
3. The upper floor ceilings have an 8 foot minimum from floor to ceiling.
4. The depth of the floor space has a 30 foot minimum.

Shown below are images taken during this task performance:

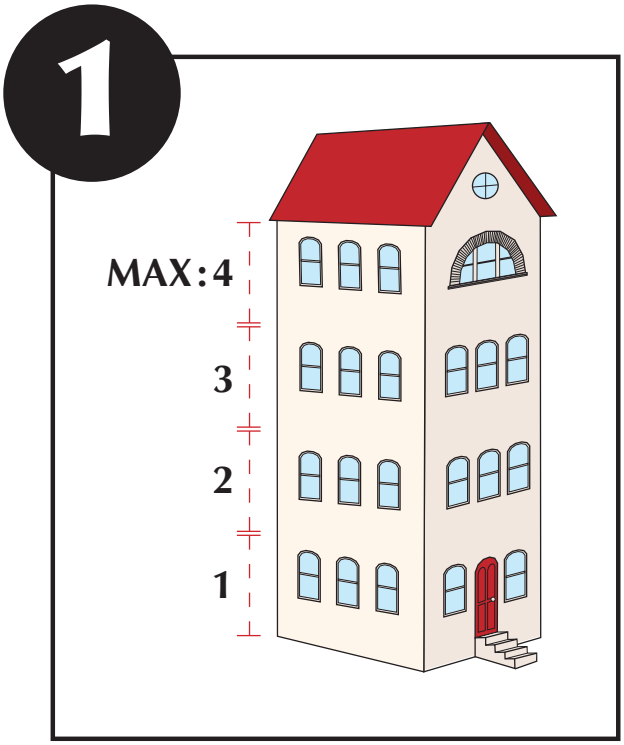


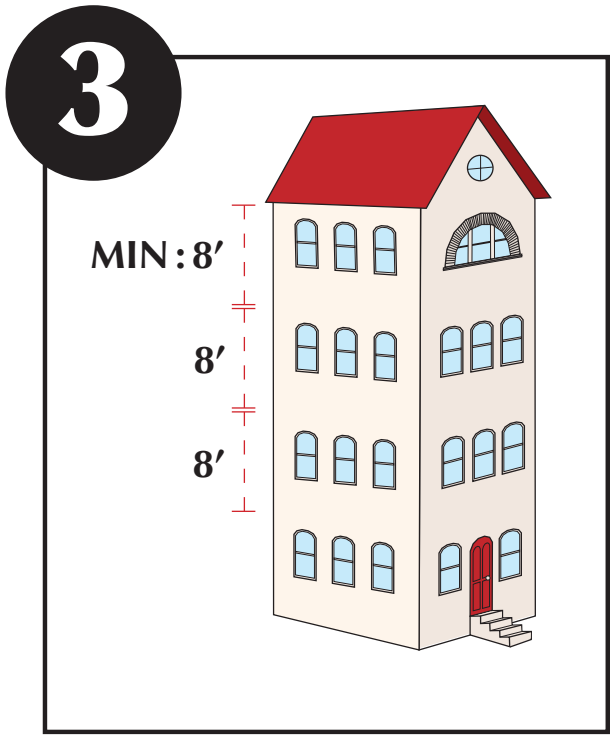




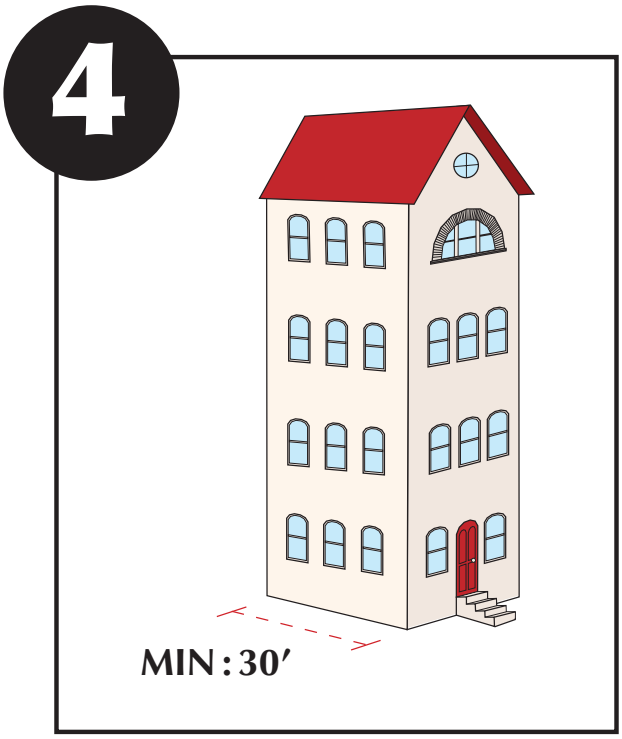





Task 2 – Creating a Building Structure Visual Instruction is shown below:







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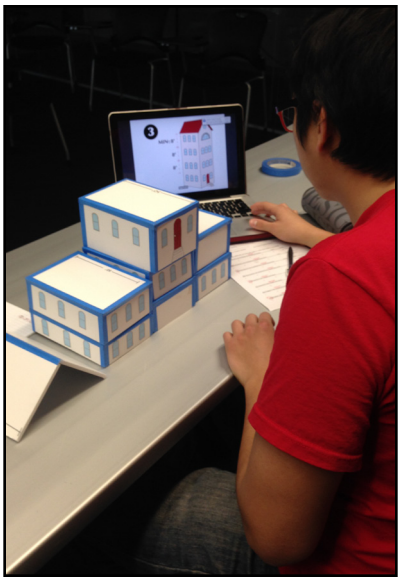
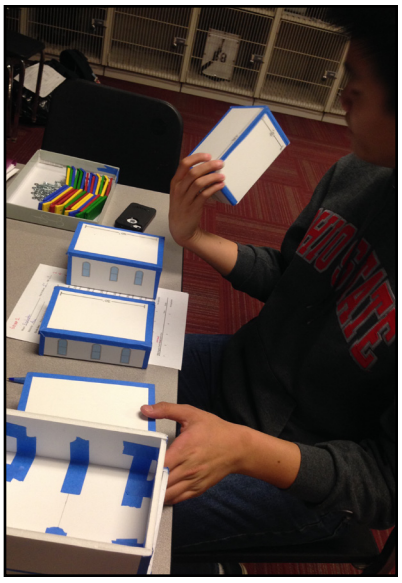
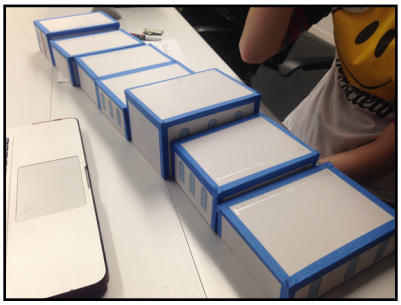
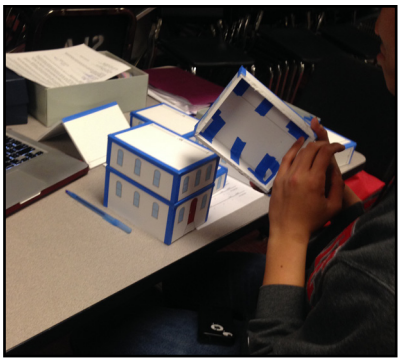
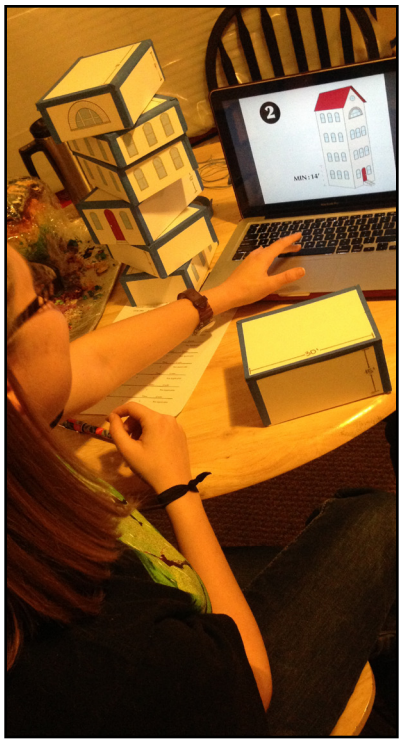










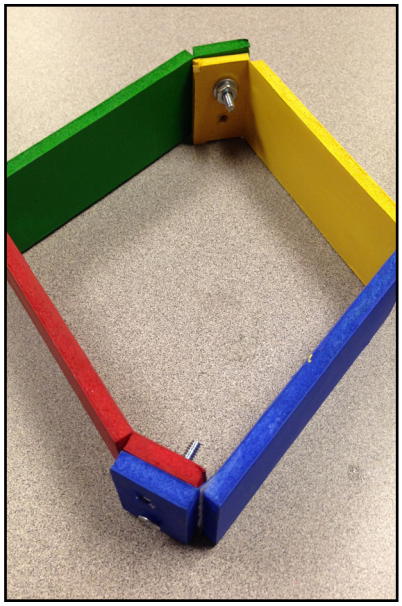
Task C & 3 is a modified version of one of Professor Jack Nasar's previous experiments. This task involved assembling an open bottom box with 2 stripes of colored cardboard and assorted washer, nuts, and bolts within 8 minutes. The subject was given different colored pieces of foam core board stripes with 2 holes drilled on each end and a tub of different sized screws, washers, and nuts and bolts to choose from. The overall instruction said: Please assemble an open bottom box with the provided supplies and given instructions.

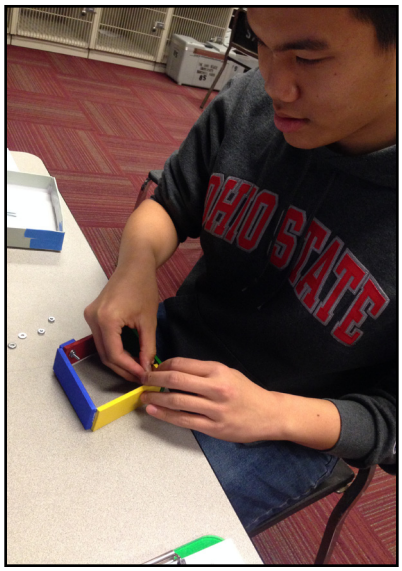
Task C – An Assembly Task Verbal Instructions included:

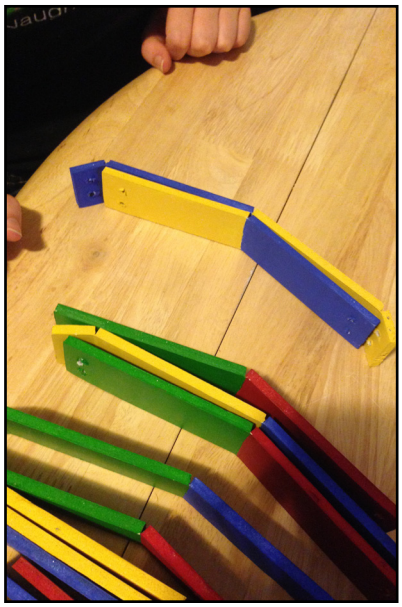
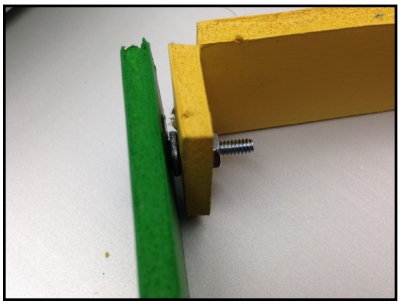
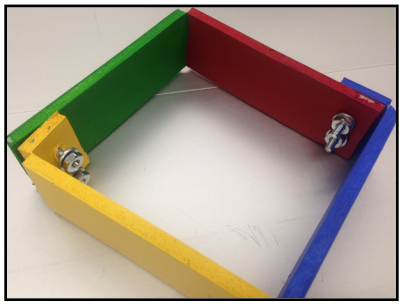
1. Select a stripe of cardboard colored blue and yellow. Crease these down in the middle and along the inner side of the holes.
2. Select a stripe of cardboard colored red and green. Crease these down in the middle.

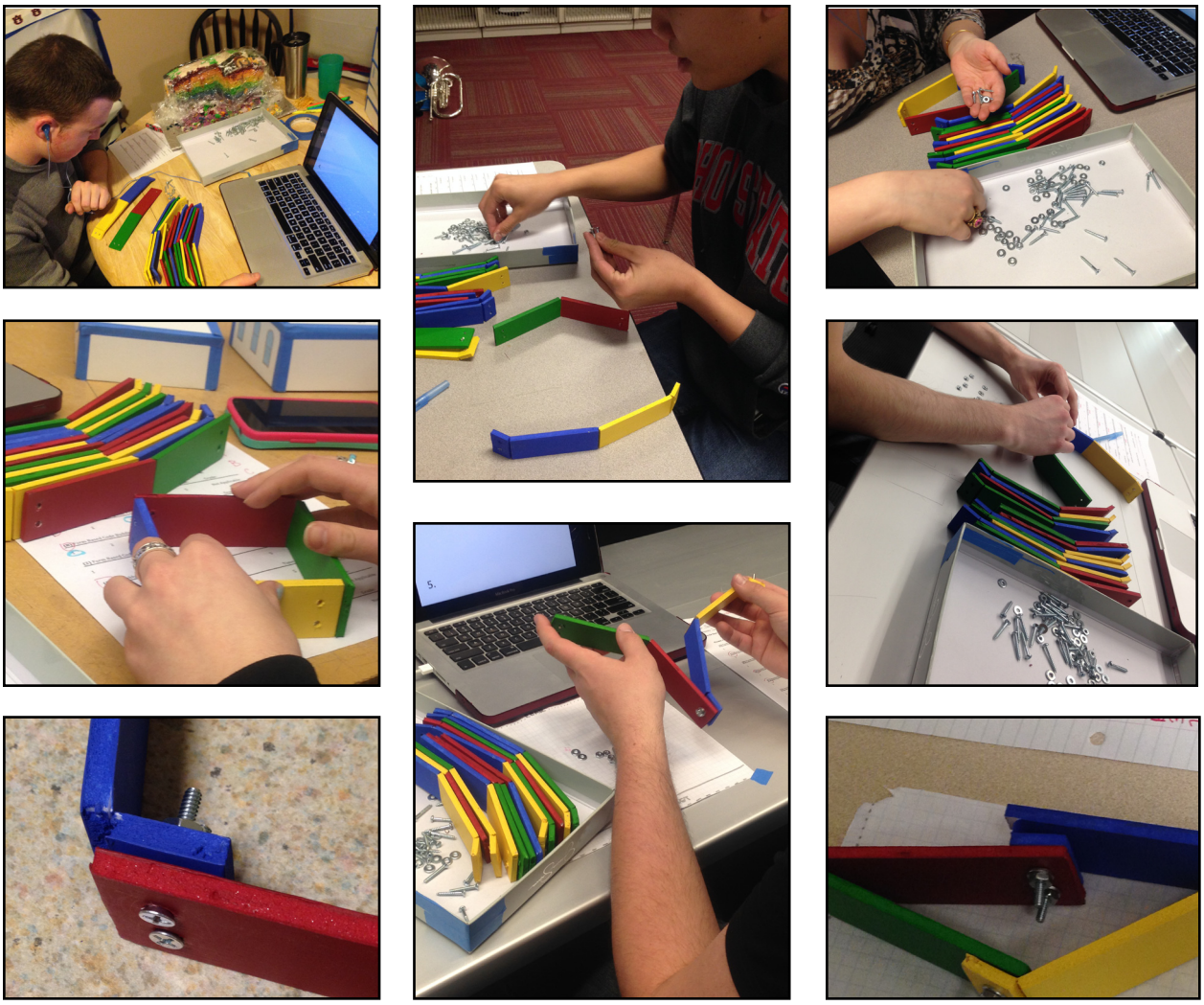
3. Find 4 flat Philip bolts along with its washers and nuts.
4. Assemble this open bottom box so that the blue side is to the left of the red in this order: flat Philip bolt, blue cardboard, red cardboard, washer, and nut.
5. Assemble this open bottom box so that the yellow side is to the left of the green in this order: flat Philip bolt, green cardboard, yellow cardboard, washer, and nut.

Shown below are images taken during this task performance:

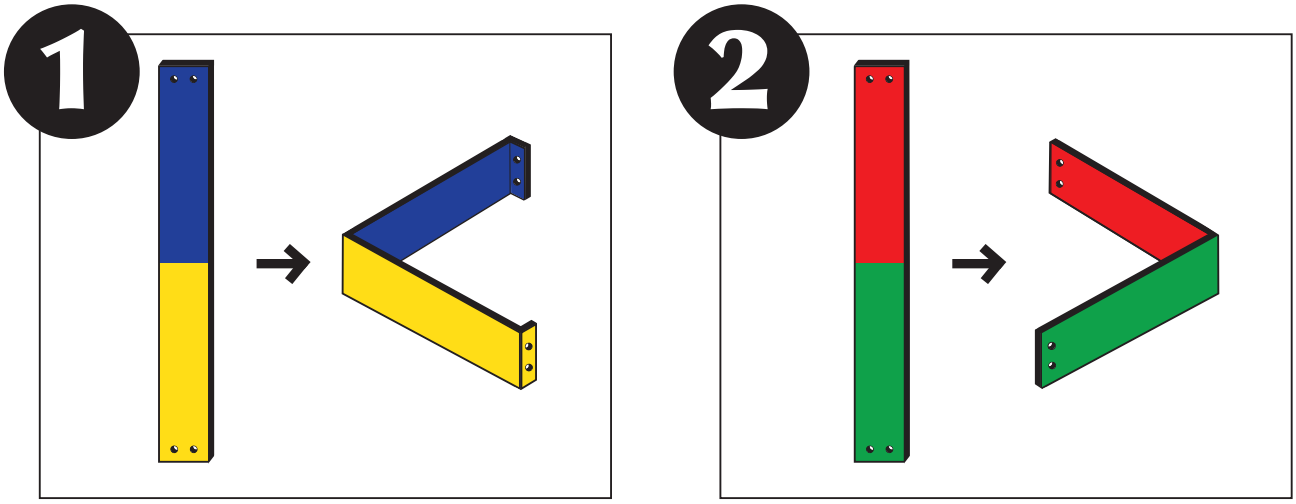



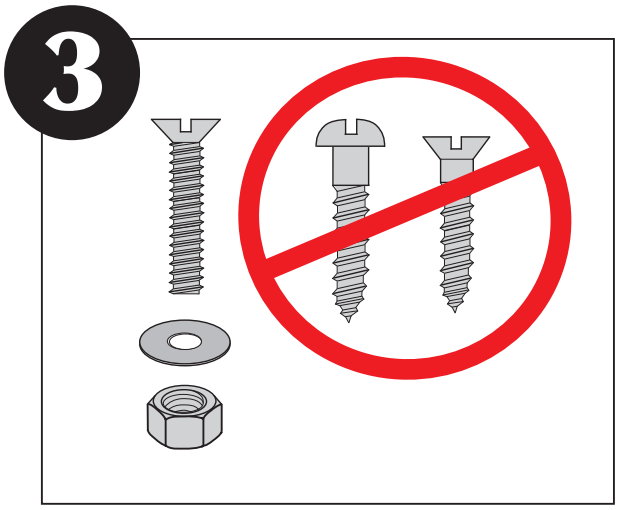



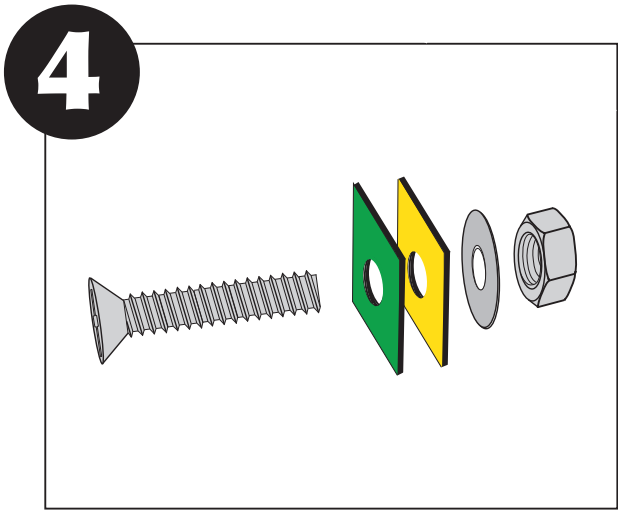




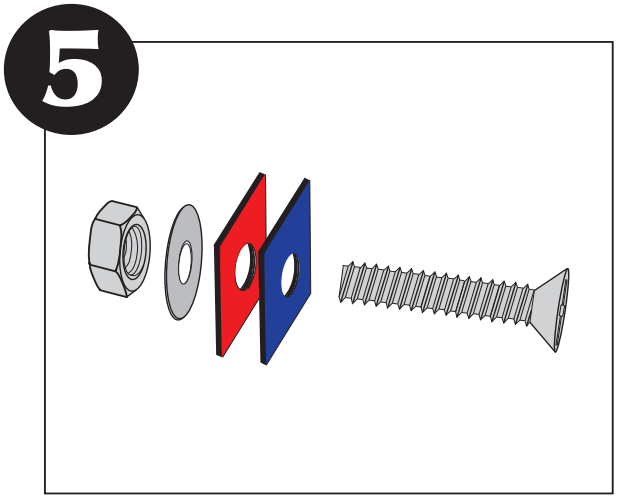


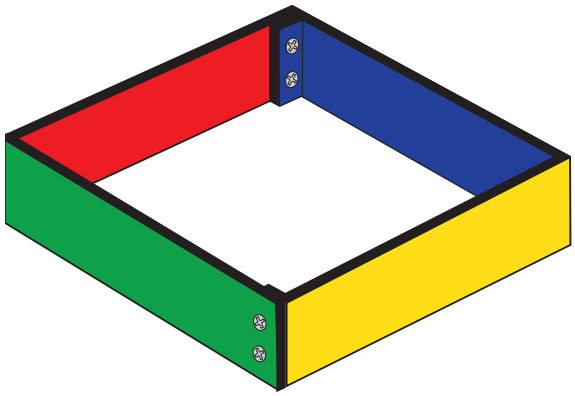
Task 3 – An Assembly Task Visual Instruction is shown below:











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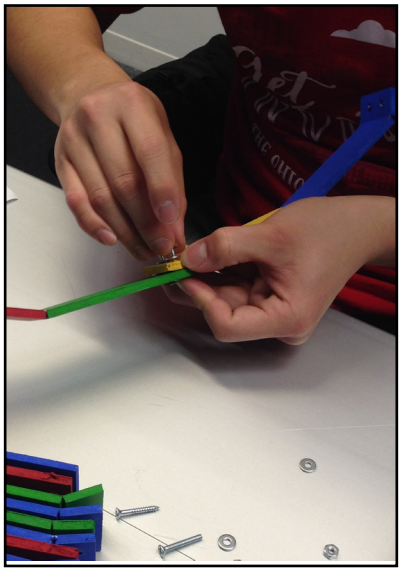
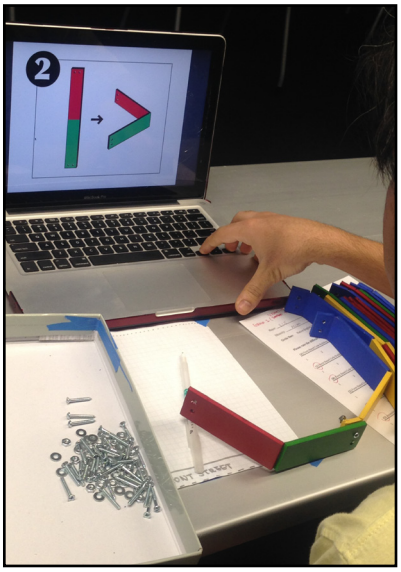
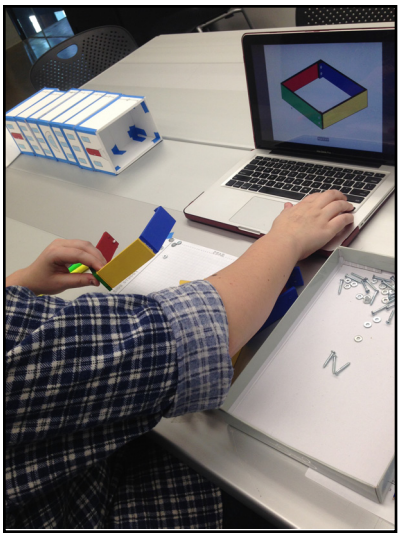
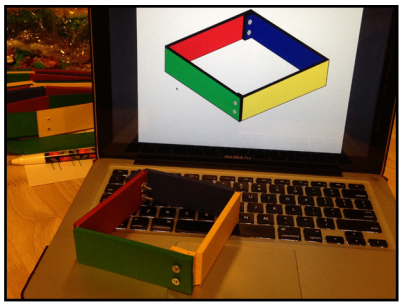
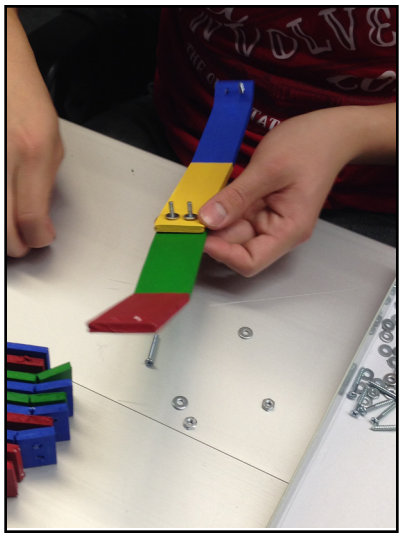





Task D & 4 is origami oriented: folding a dollar bill into a shirt. The subject was given 5-8 minutes to complete this task. A dollar bill was given to each subject as part of their compensating for partaking in the experiment and completing this task. The overall instruction said: Please fold an origami shirt with the provided dollar bill and given instructions.

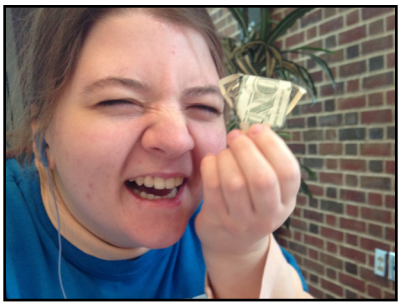
Task D – Folding an Origami Verbal Instructions included:

1. Fold a bill in half vertically (think hotdog style), then unfold, and fold both the left and right edge to the centerline.
2. At the top edge, fold the white border backwards so that it is under the bill.

3. On that same edge, fold the two corners towards the centerline so that the corners are touching each other at their tips. This will form the collar of the origami shirt.
4. Going to the bottom edge, fold the bill by dividing it into thirds. It should tuck in nicely under the collar.
5. Unfold the last step.
6. With one hand, pinch the center of the bottom of the bill. With the other hand, at the 1/3 crease mark, pull the inner edges outward to create the sleeves. You should see a diamond on the inside.
7. Tuck the end back under the collar.

Shown below are images taken during this task performance:



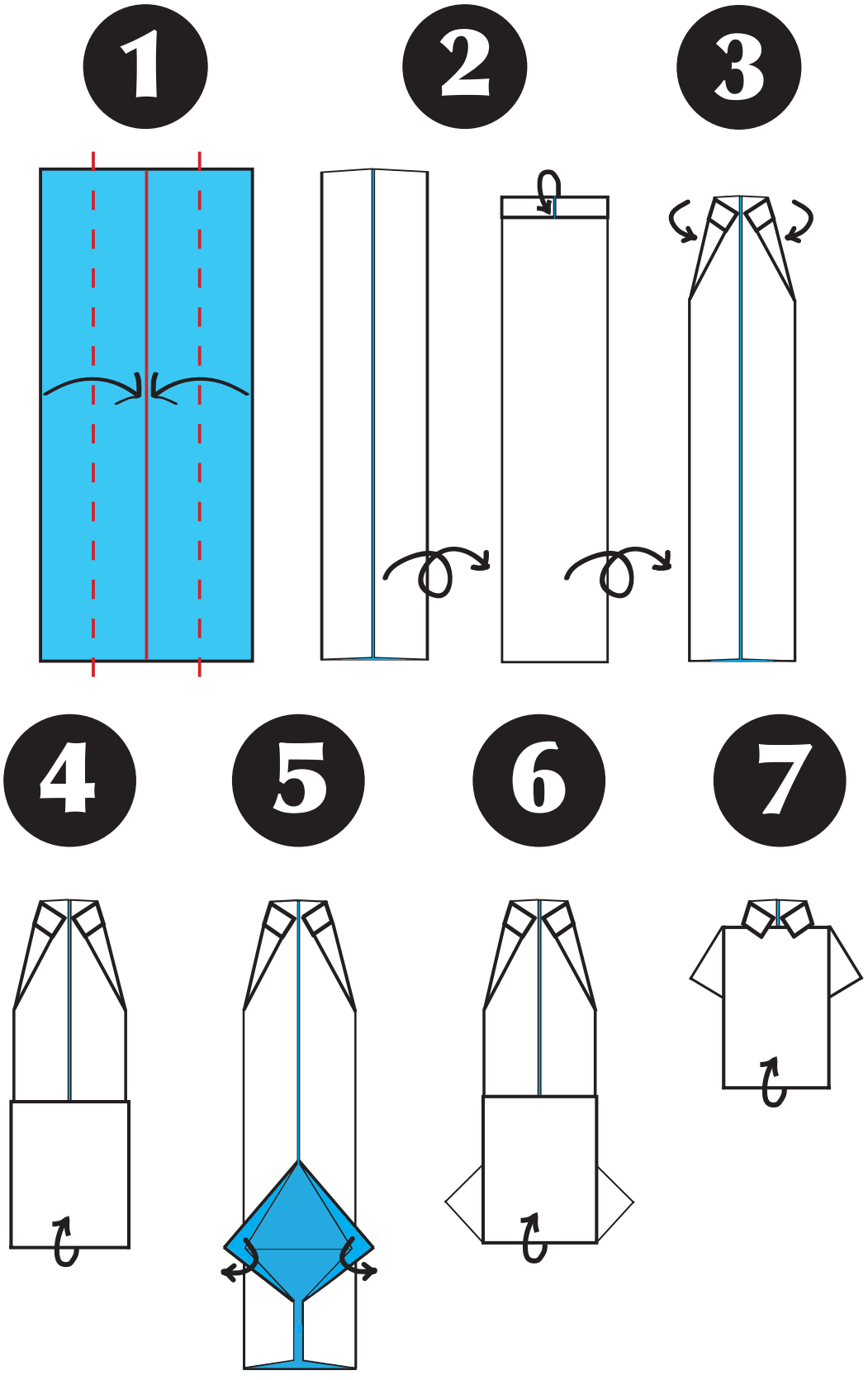








Task 4 – An Assembly Task Visual Instruction is shown below:



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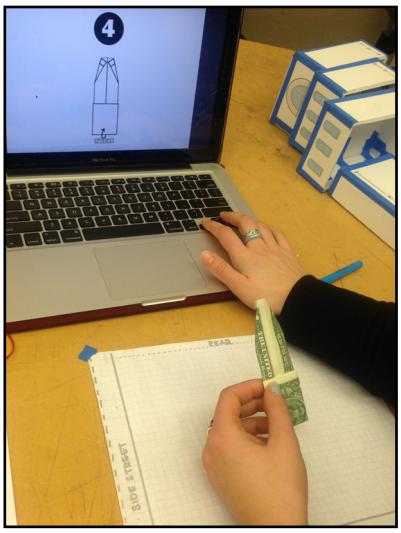



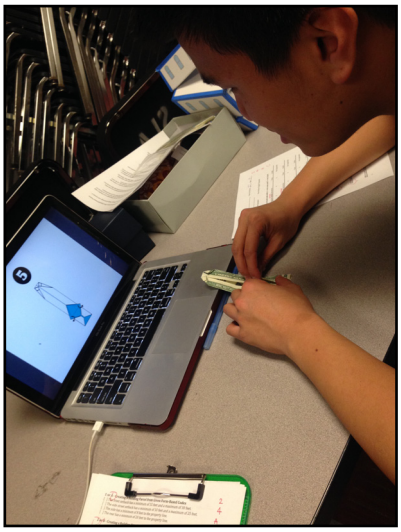

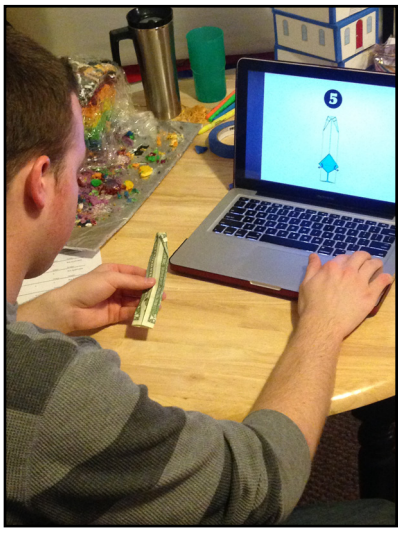

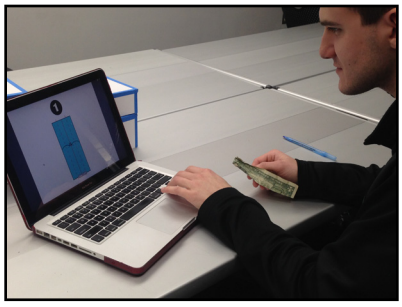
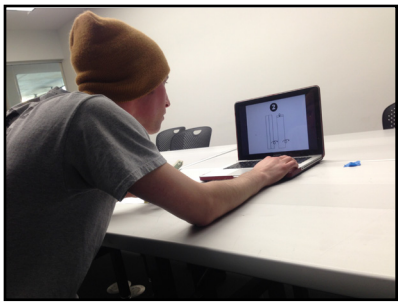

E. Data Processing

A percentage grade was given for each task. This was simply measured by how many of the steps in each instruction were completed successfully by the subject:

$$\frac{\text{\# of successfully completed steps}}{\text{\# of total steps}}$$

This was the only way for data comparison since the tasks ranged from 4 to 7 steps. A solid improvement of the visual communication group had to be seen to prove that this technique of communication is enhanced over verbal. This was done in excel, as will be shown in the analysis section below. To ensure the correct data analysis, the data was also put into the program, SPSS Statistics, to find if there was significance in the differences. The amount of time it took to complete each task will also be recorded for analysis along with the subject's personal ranking of the difficulty of each task. Latter measure is based on a likert scale with 1 being very easy and 5 being very hard.

V. Results

A. Descriptive Analysis

All results were transferred from the experiment form into an excel document. Subjects fell into two separate groups. Each subject's time of completion in minutes, grading of performance accuracy in percentages and self rating on a scale of 1 - 5 (1 being very easy and 5 being very hard) were included, along with their profile information, which included their major, year in school, age, ethnicity, and if they were a native speaker or not. Before analysis could take place, the time of completion for each task was converted from minutes to seconds.

The next step towards analysis required the grouping of each task's data into individual tables. For example, Task 1 had a set of 26 subjects with their recorded time, grade, and rating, along with their profile information. The same goes for Task A, Task 2, Task B and so on. These

can be seen in Appendix C. The averages of each measurement were found for each task and for each group within that task. The tables are shown below and their corresponding charts can be seen in the tables of Appendix D.

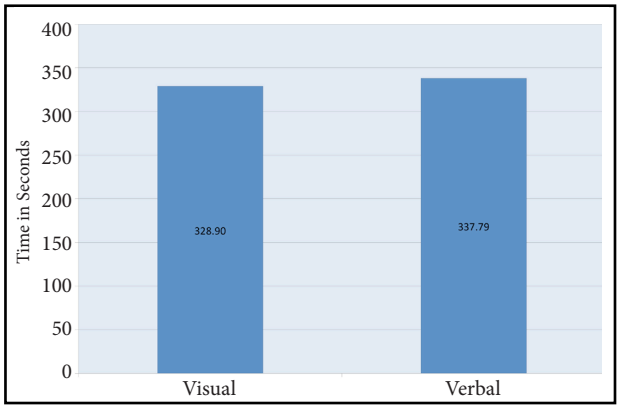

Chart 1: Average time of task completion in seconds

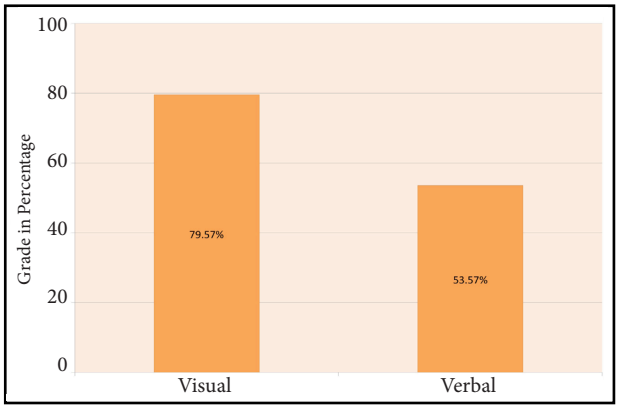

Chart 2: Average accuracy of task in percentage

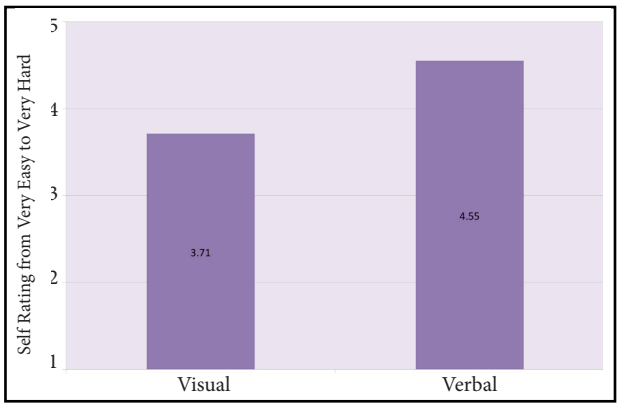

Chart 3: Average self rating of the difficulty of task

As can be seen from Charts 1-3 presented on this page, the subjects with visual instructions completed their tasks faster, with better grades and better self rating than the subjects who were given verbal instructions. Charts 4-6 show that the subjects with visual instructions in general completed the various different tasks assigned faster, with better grades, and better self rating than the subjects who were given verbal instructions. One assembly task (Task 3) was the exception. In this case, the subject took longer to do the task when instructions were given visually than when instructions were verbal. However, when considering the grade for Task 3, the subject scored better when given visual versus verbal instructions.

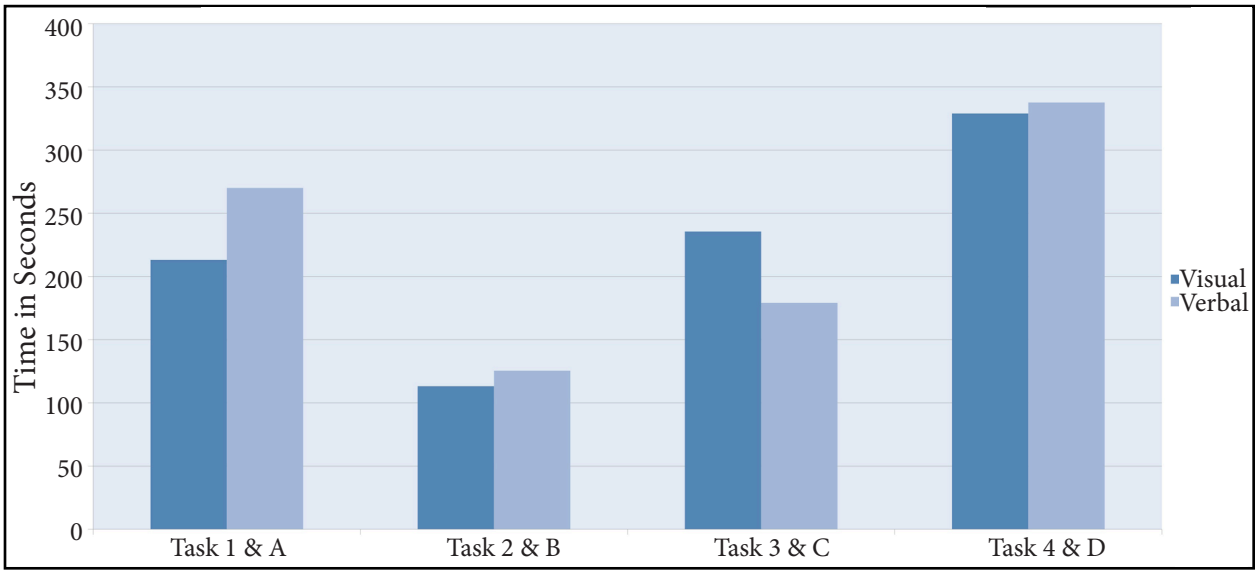

Chart 4: Average time of task completion in seconds, split by tasks

****Task 1: Creating a building parcel with visual instructions*
Task 2: Creating a building structure with visual instructions
Task 3: Assembling an open bottom box with visual instructions
Task 4: Folding an origami t-shirt with visual instructions

Task A: Creating a building parcel with verbal instructions
Task B: Creating a building structure with verbal instructions
Task C: Assembling an open bottom box with verbal instructions
Task D: Folding an origami t-shirt with verbal instructions

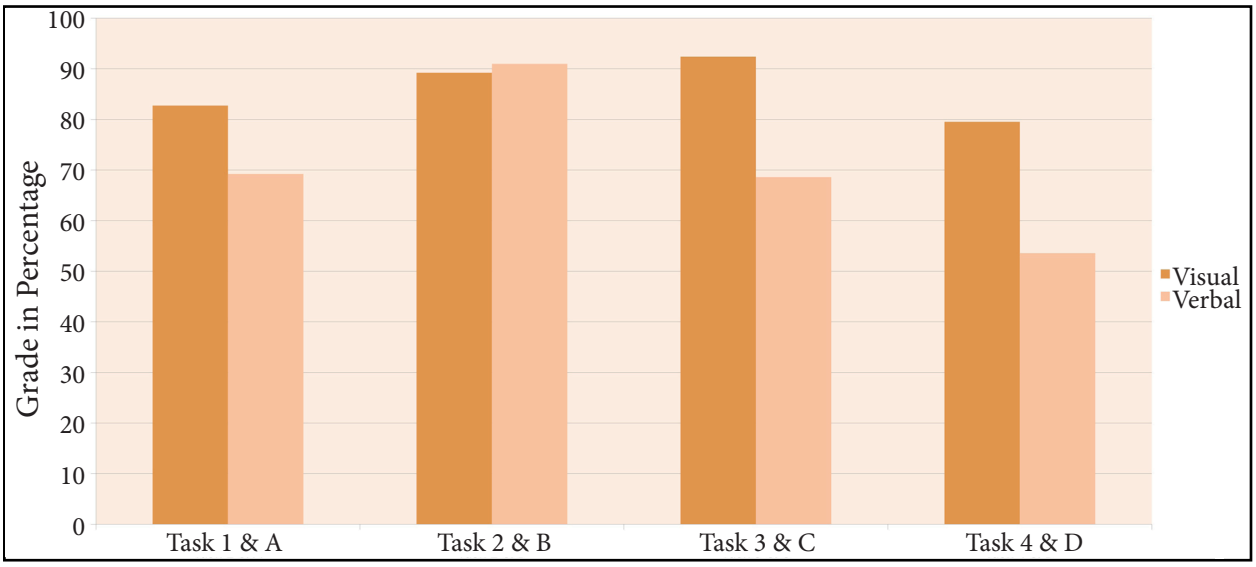

Chart 5: Average accuracy of task in percentage, split by tasks

****Task 1: Creating a building parcel with visual instructions*
Task 2: Creating a building structure with visual instructions
Task 3: Assembling an open bottom box with visual instructions
Task 4: Folding an origami t-shirt with visual instructions

Task A: Creating a building parcel with verbal instructions
Task B: Creating a building structure with verbal instructions
Task C: Assembling an open bottom box with verbal instructions
Task D: Folding an origami t-shirt with verbal instructions

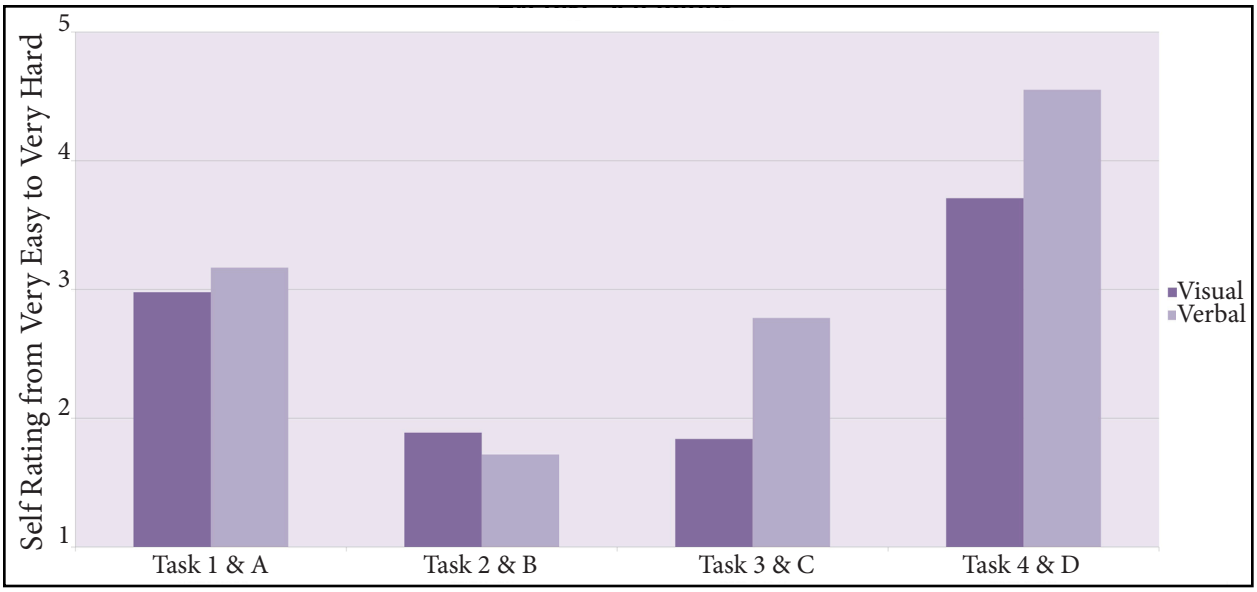

Chart 6: Average self rating of the difficulty of task, split by tasks

****Task 1: Creating a building parcel with visual instructions*
Task 2: Creating a building structure with visual instructions
Task 3: Assembling an open bottom box with visual instructions
Task 4: Folding an origami t-shirt with visual instructions
Task A: Creating a building parcel with verbal instructions
Task B: Creating a building structure with verbal instructions
Task C: Assembling an open bottom box with verbal instructions
Task D: Folding an origami t-shirt with verbal instructions

Overall, on average, subjects scored better grades, conducted tasks in less time and considered tasks to be easier when given visual over verbal instructions. As demonstrated later, this holds true under more rigorious statistical analysis. Through several analytical processes, such as the use of the Soloman Four Group Design - which can be seen in Appendix A - a final analysis was created. The last part of the descriptive analysis involved the comparison

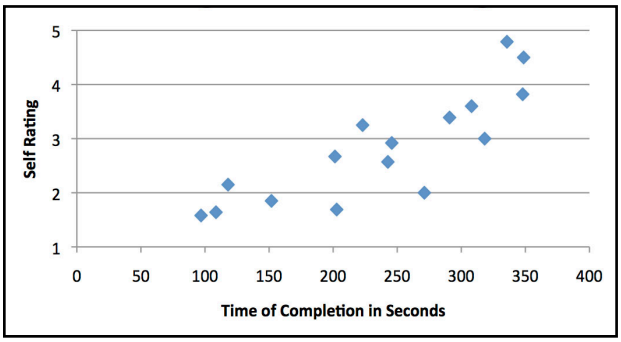

Chart 13: Subject's average time versus self rating

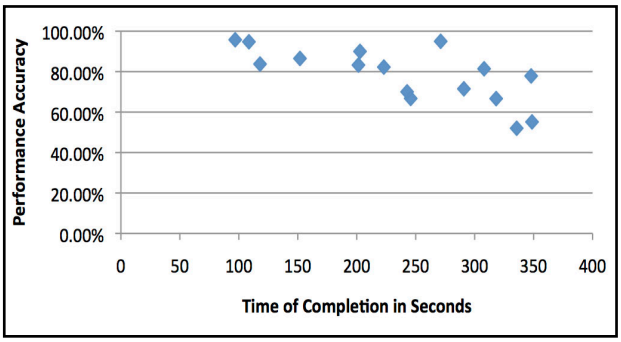

Chart 14: Subject's average time versus grade

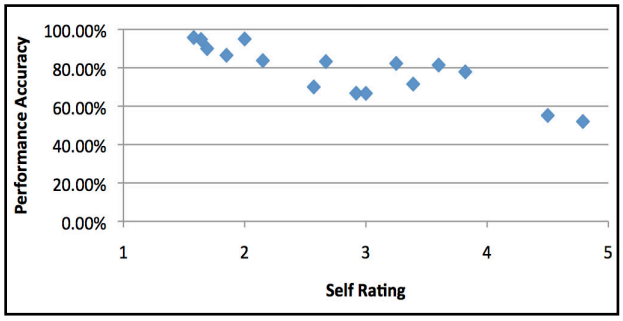

Chart 15: Subject's self rating of difficulty versus grade

of different measurements for certain relationships. The average time of completion for each task and the subject's rating of task difficulty, shown in Chart 13, has a positive relationship, meaning as the time increased, the task was viewed as more difficult. The average time of completion versus performance accuracy, shown in Chart 14, and the average subject's rating of task difficulty versus performance accuracy, shown in Chart 15, both have a negative relationship. That is to say, the performance accuracy decreased as time and task difficulty increased. All these are shown in the above plots.

The claims made in this section can only be confirmed by a concurring statistical analysis. The next section of this chapter includes correlations to more fully understand the statistical significance of relationships between grade, time, and self rating. Correlation indicates a statistical relationship between two plotted measurements. Statistical significance is the probability that an effect or relationship between specific factors, such as verbal and visual instructions and their performance accuracy, is not due to just chance itself.

B. Correlations

Statistical analysis required the use of the program, SPSS Statistics. Before correlations could be found, the raw data had to be transferred from excel. The data was rearranged and recoded. This process is explained in Appendix E. The degree to which the three variables (time,

grade, rating) go together was observed using correlations. Table 1 demonstrates the results. Examining the Pearson correlation, the closer the number is to 1 or -1, the closer the relationship is between variables. As can be seen from Table 1, grade and time do not have a very strong relationship (-0.138).

The relationship between time and rating is a little stronger (.505) such that as the amount of time it took to complete a task increased, so does the score for self rating. In the case of grade and rating, the relationship is negative. The higher the grade, the easier the task. The relationship is not too strong (-.471). If all three variables were highly correlated with one another, this would suggest that they are measuring the same construct. However, because they were not very strongly correlated (.7 or -0.7 or higher), the statistical analysis suggested to continue using all 3 measures for testing. The three variables had statistical significance but not enough correlation in a way that would suggest combining into one construct.

Table 1: Correlation between Time, Grade, and Rating

Pearson Correlation	Time	Grade	Rating
Time	1	-.138	.505
Grade	-.138	1	-.471
Rating	.505	-.471	1

In addition to a correlation analysis, the Cronbach's Alpha reliability test suggests the same results (-.054). The value is negative due to a negative average covariance among the three variables. Because it was less than .07, it was not advisable to create one construct from the three variables. Therefore, statistical analysis was conducted on all three variables of time, grade and rating separately.

B. Repeated Measure Analysis

Using repeated measures design, tests were conducted to identity the significance and effects when:

1. Subjects received visual and verbal instruction;
2. The task was form based or assembly; and
3. The order of the task varied from visual first to verbal or vice versa.

Table 2 shows the results. As Table 2 illustrates, the effect of subjects receiving instructions either verbally or visually was statistically significant (.001). Any number less than .05 means it is significant. The effect size, measured in partial eta squared, was large at .669. Partial eta squared measures the degree of association between two or more variables and it is considered large when it is greater than .50.

Table 2: Significance and Effect Sizes for Grade

Source - Sphericity Assumed	Significance	Partial Eta Squared
Verbal vs. Visual	.001	.669
Task	.000	.759
Order	.228	.141
Verbal vs. Visual * Task	.011	.493

As illustrated in Table 2, the effect of subjects performing form based codes or an assembly task was significant (.000) with a large effect size (.759). The same cannot be said for the order in which the tasks were performed, whether it was visual first and then verbal or vice versa. However, the effect of visual or verbal instructions does depend on the task. This was significant at the .011 level, but the effect was smaller. This suggests that a verbal versus visual instruction has an effect depending on which task was being performed.

Effect size was further examined by testing the between subject effects. The estimated marginal means was examined for verbal versus visual instructions at the 95% confidence interval. Based on the mean grades, Table 3 illustrates that it was significantly easier for subjects when the task was conducted with visual instructions (86.5%) rather than verbal instructions (72.3%).

Table 3: Results for Mean Grades based on Visual or Verbal Instructions

Verbal vs. Visual	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Visual	.865	.014	.834	.897
Verbal	.723	.025	.667	.779

Table 4: Results for Mean Grades based on Form Based Code or Assembly Tasks

Task	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Form Based Code	.838	.013	.808	.868
Assembly	.750	.017	.713	.787

Based on the mean grades, Table 4 illustrates that it was significantly easier when the task dealt with form based codes (83.8%) rather than the assembly performance (75.0%). In examining whether the task was conducted from verbal instructions or visual instructions versus whether the task involved form based codes or was an assembly performance, it can be seen that those with visual instructions received a better grade than those who completed the tasks with verbal instructions. However, the difference can be seen more when examining the mean of grades between visual and verbal instructions of the assembly tasks, 86.4% and 63.7%, respectively. The form based code tasks only had a 5.7% difference as compared to the 22.7% for the assembly task. This is illustrated in Table 5. Table 5 suggests that regardless of being given

visual or verbal instructions, subjects received better grades for the form based code tasks rather than assembly. But if the subjects received visual instructions for assembly, they received a better grade than if they received the instructions verbally.

Table 5: Mean Grades when Comparing Tasks and Instructions

Verbal vs. Visual * Task	Visual	Verbal
Form Based Code	86.6%	80.9%
Assembly	86.4%	63.7%

**the two variables being compared*

The same analysis was completed for the variables rating and time. The results were a little different for time and rating than grade. For the measure self rating, there was only two significant effects: As Table 6 illustrates, the effect of subjects receiving instructions either verbally or visually is statistically significant (.005) with a large effect (.570). The effect of subjects performing form based codes or an assembly task was significant (.000) with a large effect size (.933).

Table 6: Significance and Effect Sizes for Self Rating

Source - Sphericity Assumed	Significance	Partial Eta Squared
Verbal vs. Visual	.005	.570
Task	.000	.933
Order	.413	.068
Verbal vs. Visual * Task	.068	.295

Based on the mean self rating, Table 7 illustrates that it was significantly easier for subjects when the task was conducted with visual instructions (2.61) rather than verbal instructions (3.09). Table 8 illustrates that it was significantly easier for subjects when the task dealt with form based codes (2.43) rather than the assembly performance (3.26). When examining whether the subjects completed tasks with visual instructions or verbal instructions first, results showed that it was not a significant (.413) and neither was comparing it

when compared to the type of task the subject had to perform.

Table 7: Results for Mean Self Rating based on Visual or Verbal Instructions

Verbal vs. Visual	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Visual	2.61	.079	2.43	2.78
Verbal	3.09	.076	2.92	3.25

Table 8: Results for Mean Self Rating based on Form Based Code or Assembly Tasks

Task	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Form Based Code	2.43	.054	2.31	2.55
Assembly	3.26	.054	3.14	3.38

For the measure time, the only statistically significant effect was for task (.287) and the effect was large (.900). This can be seen in Table 9. Table 10 demonstrates that the assembly task (309.7) took much longer than the form based code task (180.5), suggesting subjects completed the planning task quicker than the assembly task.

Table 9: Significance and Effect Sizes for Time

Source - Sphericity Assumed	Significance	Partial Eta Squared
Verbal vs. Visual	.005	.570
Task	.000	.933
Order	.413	.068
Verbal vs. Visual * Task	.068	.295

Table 10: Results for Mean Time based on Form Based Code or Assembly Tasks

Task	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Form Based Code	180.5	9.38	159.6	201.4
Assembly	309.7	13.1	280.6	338.8

VI. Discussion

There are a number of significant conclusions that can be drawn from this experiment and analysis. First, subjects received better grades and better self rating scores if they were given visual rather than verbal instruction for the different tasks, whether these tasks were for assembly or form based codes. Second, subjects found form based code tasks easier than assembly tasks, suggesting that planning related tasks are easier to conduct for most subjects. Third, it took subjects less time to perform form based code tasks than assembly task. Lastly, the subjects received the highest grades when they received visual rather than verbal instructions.

As mentioned, it was significantly easier when the task dealt with form based codes over the assembly performance. This finding has a strong implication in the practice of urban planning. When communicating planning techniques in the developing world or non-native

English speaking countries, providing visual instructions and information will be useful when it comes to understanding planning concepts, such as form based codes. Visual instructions and information can help overcome language and cultural barriers. To better the outcomes of engagment and understanding in any public meeting or educational training when there are language and cultural barriers, it's important to add a visual component to help with information sharing.

VII. Conclusion

This thesis set out to answer the following questions, 1) Is there a difference in our ability to understand planning concepts when given visual compared to verbal instructions? 2) Are planning concepts easy to understand regardless of whether or not they are explained using visual versus verbal techniques? Although English is considered one of the main internationally known languages, there are different levels of knowledge and understanding.

People in different communities have different ways of using linguistic means to communicate. Things as simple as asking questions, offering advice and information, or exchanging compliments between cultures, can be interpreted different, either for better or worse. For example, American businessmen tend to be direct as opposed to Japanese businessmen's indirectness before getting down to business. Even in the same cultural context, slower talking

partners could accuse the faster one of not giving them the chance to talk or not being interested in what they have to say. The faster partner could accuse the slower one of not talking to them or saying what is on their mind. Intonation is made up of degrees and shifts in pitch, loudness, and rhythm. Thus, a pause in the wrong place could mean a misunderstanding that causes a whole conversation to go awry.

The main goal of data visualization is to communicate information clearly and effectively through graphical means (Friedman 1987). My experiment was based on the Solomon Four Group Design to compare which communication technique, whether it is visual or verbal, was more effective when transferring knowledge between language and cultural barriers. The four tasks, two based on planning related concepts and two assembly tasks, were given using verbal or visual instructions.

Through the statistical analysis of the data's time, grade, and self rating with the use of correlation, within-subject and between-subject test, the questions this thesis asked were answered. There was a statistically significant effect when instructions were given visually over verbal instructions. The effect of subjects performing form based codes or an assembly task was also significant, favoring the planning related concept. This suggests that there is a difference in our ability to understand planning concepts when given visual compared to verbal instructions.

As mentioned, subjects completed the tasks faster, with better accuracy, and with significantly more ease when given visual instructions over verbal. There was also a strong implication in the practice of urban planning because subjects also completed the tasks faster, with better accuracy, and with significantly more ease when their task involved form based codes over the assembly performance. Visualization can help overcome the lack of common language

and cultural context when transferring knowledge. This suggests that planning concepts are easier to understand than assembly tasks egardless of whether or not they are explained using visual versus verbal techniques.

For a possible future study, the tasks that were used in this study did not require any normative judgment; therefore, it would be quite different if the performances of the subjects were required to change their moral standards, norms, and/or ideological beliefs to complete a task. An alternative question for future research could be to ask if visual communication can help reconcile opposing or incompatible preferences and ideologies during policy decision-making processes.

Work Cited

Babbie, Earl. (2008). *The Basics of Social Research.* Belmont, CA: Thomson Wadsworth.

Blanco, H. (1994). *How to Think about Social Problems: American Pragmatism and the Idea of Planning.* Westport, CT: Greenwood: Greenwood Press.

Brooks, M. P. (2002). *Planning Theory for Practitioners.* Chicago, IL: Planners Press, American Planning Association.

Critchley, Peter (2001). *The Rational Freedom of Jean-Jacques Rousseau.* Academia: Share Research.

Cunningham, Una. (2012). *Using Nigerian English in an International Academic Setting.* Stockholm University.

Erickson, Frederick, and Jeffrey Shultz. (1982). *The Counselor as Gatekeeper: Social Interaction in Interviews.* New York: Academic Press.

Fischer, Frank. (2003). *Reframing Public Policy: Discursive Politics and Deliberative Practices.* Oxford University Press.

Fischer, Frank. (2003). *Public Policy as Discursive Construct: Social Meaning and Multiple Realities.* Oxford University Press.

Forester, John. (2006). *Challenges of Deliberation and Participation.* Third Edition. Oxford: Blackwell Publishing.

Forester, John. (1993). *Critical Theory, Public Policy and Planning Practice.* Albany, New York: University of New York.

Friedman, John. (1987). *Planning in the Public Domain: From Knowledge to Action.* Princeton University Press, Princeton, NJ.

Grimes, Barbara F. (1988). *Ethnologues: Languages of the World.* Dallas: Summer Institute of Linguistics.

Gumperz, John J. (1982). *Discourse Strategies.* Cambridge: Cambridge University Press.

Habermas, J. (1989). *The Structural Transformation of the Public Sphere.* Cambridge, MA: MIT Press.

Healey, Patsy. (1992). *Planning Through Debate: The Communicative Turn in Planning Theory.* Town Planning Review.

Healey Patsy. (2008). *The Pragmatic Tradition in Planning Thought.* Journal of Planning Education and Research.

Huxley, M. (2000). *The Limits to Communicative Planning.* Journal of Planning Education and Research.

Innes, Judith E. (1998). *Information in Communicative Planning.* Journal of the American Planning Association.

Innes, Judith E. (1996). *Planning through Consensus Building: A New View of the Comprehensive Planning Ideal.* Journal of the American Planning Association.

Innes, Judith E.; Gruber, Judith. (2005). *Planning Styles in Conflict.* Journal of the American Planning Association.

Keir, Glynniss. (2013) *Definition of Language in English.* Oxford University Press.

Koch, Barbara Johnstone. (1983). *Presentation as proof: The language of Arabic rhetoric.* Anthropological Linguistics.

Scollon, Suzanne B.K. (1982). *Socialization to Non-intervention and Its Relation to Linguistic Structure.* Doctoral dissertation, University of Hawaii.

Smith, L. E., & Rafiqzad, K. (1979). *English for Cross-Cultural Communication: The Question of Intelligibility.* New York: St. Matrin's Press.

Tannen, D. (1984) *"The Pragmatics of Cross-Cultural Communication."* Applied Linguistics.

Tannen, D, & Saville-Troike, M. (1985). *Perspectives on Silence.* Norwood, NJ: Ablex Publication Corporation.

Wang. Haiyan. (2009). *Nonverbal Communication and the Effect on Interpersonal Communication.* Journal of Asian Social Science.

Yiftachel, Oren. (1998). *Planning and Social Control: Exploring the Dark Side.* Journal of Planning Literature.

Appendix A

As mentioned before in the methodology section, the Soloman Four Group Design is used as part of the analysis process. The following tables and charts correspond to each label A-D, gathering different comparisons for futher analysis of the level of understanding between giving visual instructions versus verbal instructions. The average accuracy of tasks, also known as average grade, was used in this analysis section.

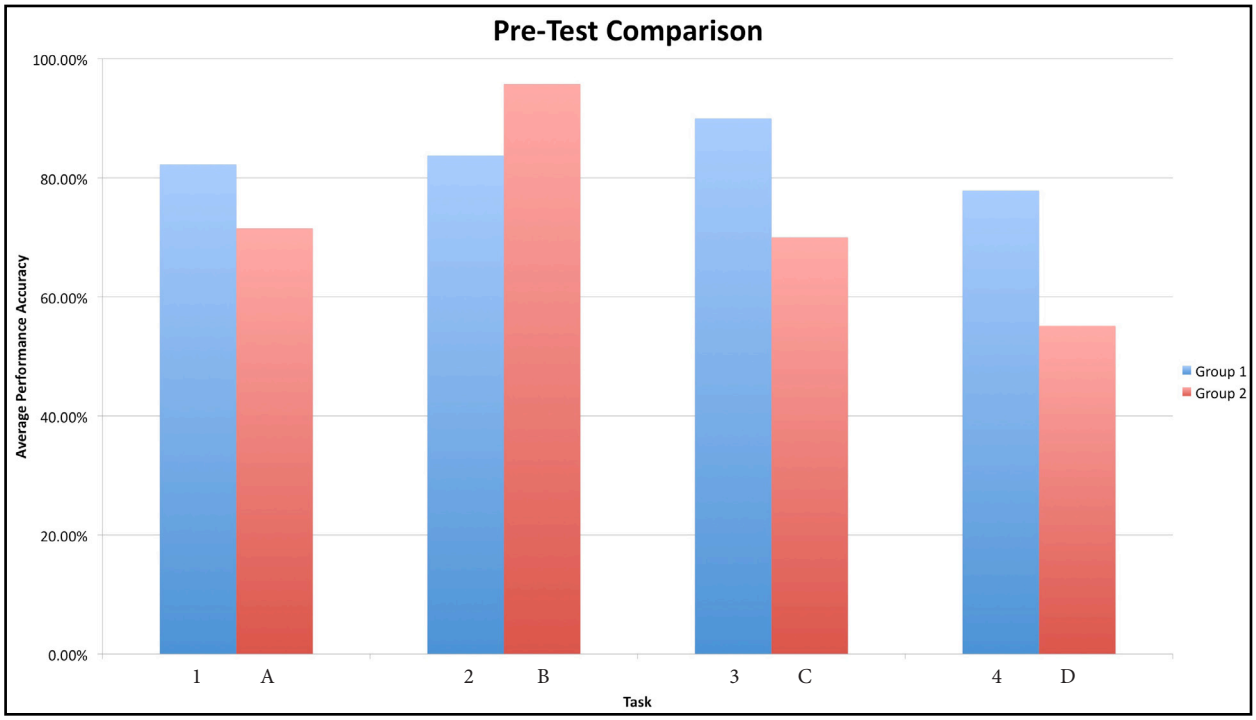

Chart 7: Label A - comparing the level of understanding between the verbal and visual group's first set of tasks

Group 1	Group 2
(1) 82.25%	(A) 71.50%
(2) 83.75%	(B) 95.75%
(3) 90.00%	(C) 70.00%
(4) 77.86%	(D) 55.14%

Table 11: Pre-test Comparison

Group 1's first set of tasks, visual performance was usually better than Group 2's verbal performance when comparing accuracy with the same anomaly seen before with Task 2&B.

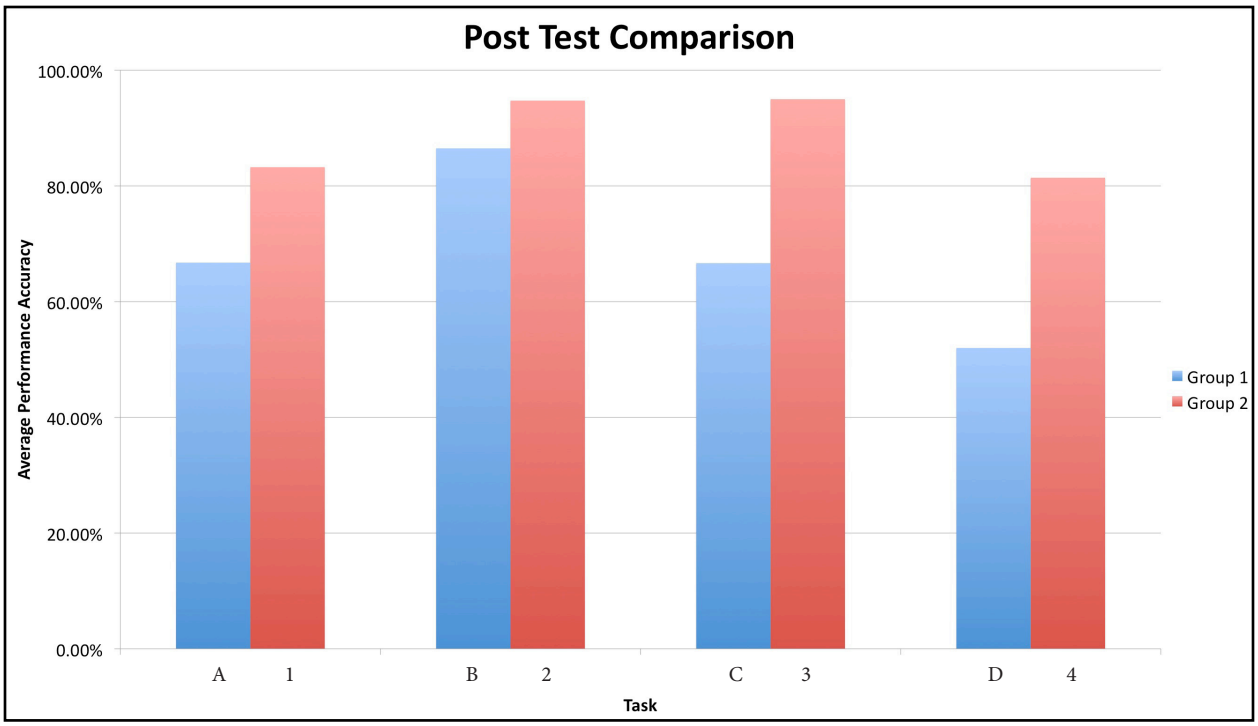

Chart 8: Label B - comparing the level of understanding between the verbal and visual group's second set of tasks

Group 1	Group 2
(A) 66.75%	(1) 83.25%
(B) 86.50%	(2) 94.75%
(C) 66.66%	(3) 95.00%
(D) 52.00%	(4) 81.42%

Table 12: Post-Test Comparison

Group 1's second set of tasks, verbal performance was worse than Group 2's second set of tasks, visual performance when comparing accuracy.

As can be seen from Chart 7 & 8, the subjects with visual instructions (labeled as numbers 1-4) performed with better accuracy in general than the subjects with verbal instructions (labeled as letters A-D). It did not matter if they were given the visual instructions as their first set of tasks or as their second set of tasks. However, there was the same exception of Task 2 & B in just the pre-test comparison. All other comparisons showed a better performance from the subjects when they were given visual instructions over verbal instructions. The comparison of the subject's pre- (label A) and post (label B) test show how useful it is to have visual communication techniques.

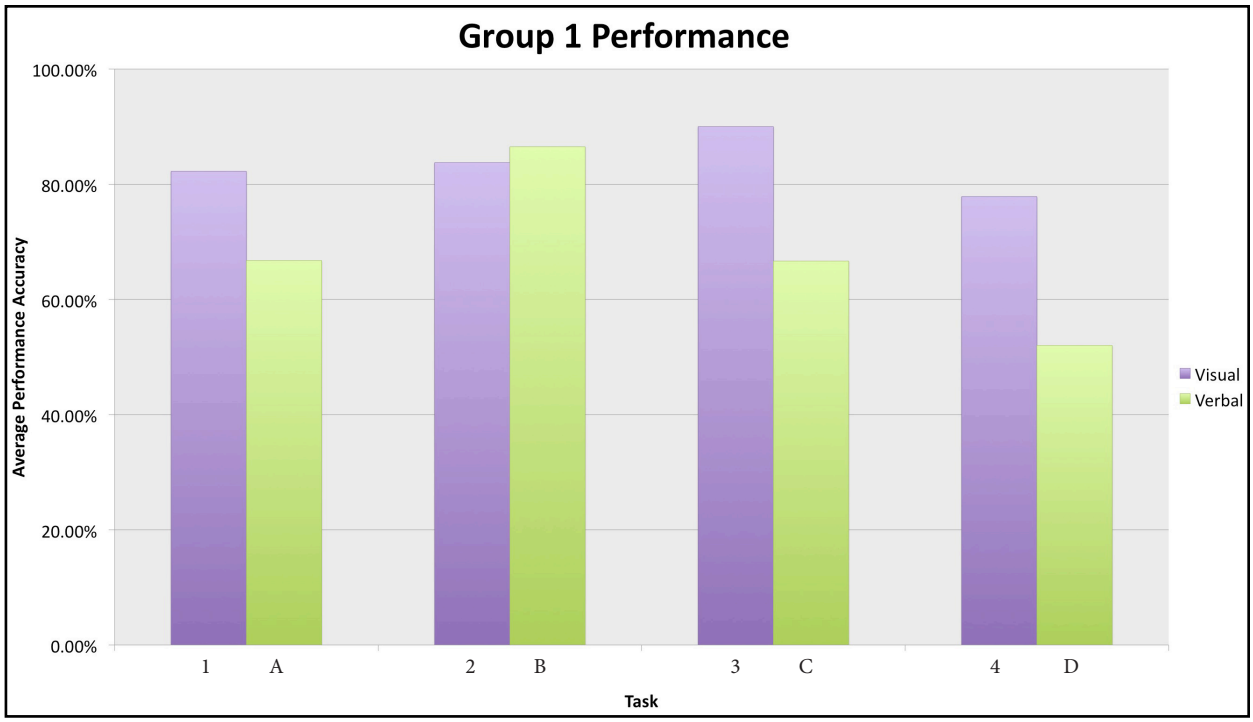

Chart 9: Label C - comparing the level of understanding of tasks within Group 1

Visual	Verbal	Difference	Percent Difference
(1) 82.25%	(A) 66.75%	-15.50%	-18.84%
(2) 83.75%	(B) 86.50%	2.75%	3.28%
(3) 90.00%	(C) 66.66%	-23.34%	-25.93%
(4) 77.86%	(D) 52.00%	-25.86%	-33.21%

Table 13: Group 1 Performance

When looking at the chart and table, it can be seen that Group 1's first set of tasks, visual performance was usually better than its second set of tasks, verbal performance when comparing accuracy. Group 1 had to complete their tasks with visual instructions first and verbal instructions second. Again, taking out the anomaly of Task 2 & B, subjects in Group 1 usually performed with better accuracy when they were given visual instructions over the verbal instructions. This can be also be seen in the decrease in percent difference in the table, which ranged from -33.21% to -18.84% with the exception of the 3.28%. Verbal instructions were given as their second set of tasks and the subject's performance decreased.

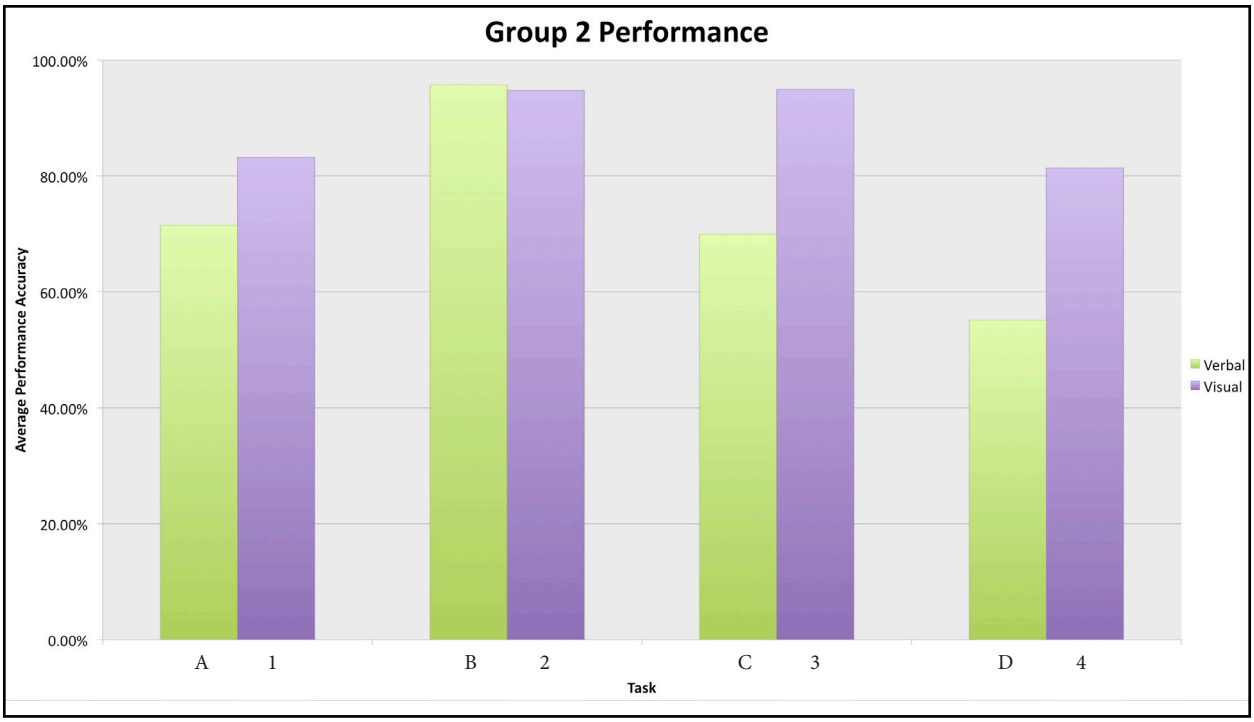

Chart 10: Label D - comparing the level of understanding of tasks within Group 2

Verbal	Visual	Difference	Percent Difference
(A) 71.50%	(1) 83.25%	11.75%	16.43%
(B) 95.75%	(2) 94.75%	-1.00%	-1.04%
(C) 70.00%	(3) 95.00%	25.00%	35.71%
(D) 55.14%	(4) 81.42%	26.28%	47.66%

Table 14: Group 2 Performance

When looking at the chart and table, it can be seen that Group 2's first set of tasks, verbal performance was usually worse than its second set of tasks, visual performance when comparing accuracy. Group 2 had to complete their tasks with verbal instructions first and visual instructions second. Again, taking out the anomaly of Task 2 & B, subjects in Group 2 usually performed with better accuracy when they were given visual instructions over the verbal instructions. This can be also be seen in the increase in percent difference in the table, which ranged from 11.75% to 26.28% with the exception of the -1.00%. Visual instructions were given as their second set of tasks and the subject's performance increased.

After seeing the results from the Soloman Four Group Design, the next part of the analysis involved comparing the verbal and visual instructions to themselves between Group 1 and 2. The point of this comparison was to see if there was a difference in the performances of the visual tasks when given at different times. The subjects of Group 1 were given visual instructions first while Group 2 had verbal instructions, then vice versa. The tables and charts comparing Group 1 and 2's task performance when given verbal instructions are shows below while the ones with visual instructions are on the next page.

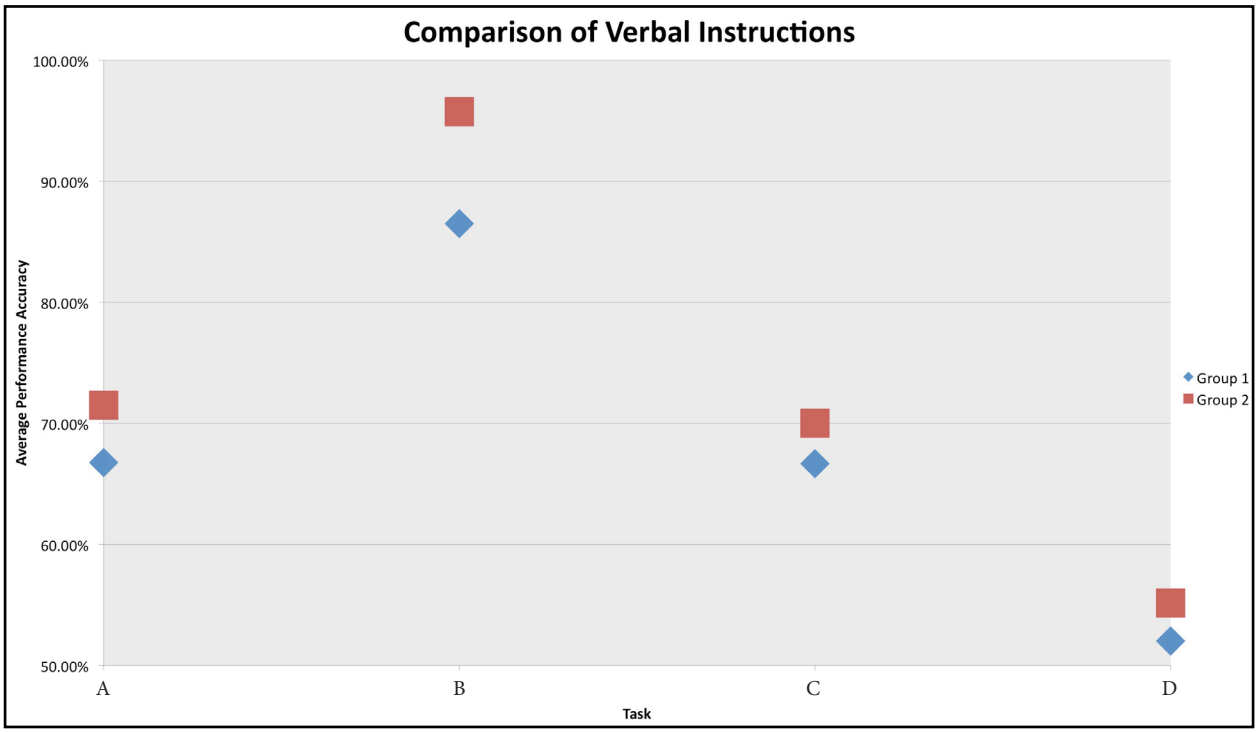

Chart 11: comparing the task performance of Group 1 and 2 when given verbal instructions

Group 1	Group 2
(A) 66.75%	71.50%
(B) 86.50%	95.75%
(C) 66.66%	70.00%
(D) 52.00%	55.14%

Table 15: Comparing Performance of Verbal Instructions

Overall, Group 2 performed better in its tasks when given verbal instructions than Group 1, when comparing accuracy.

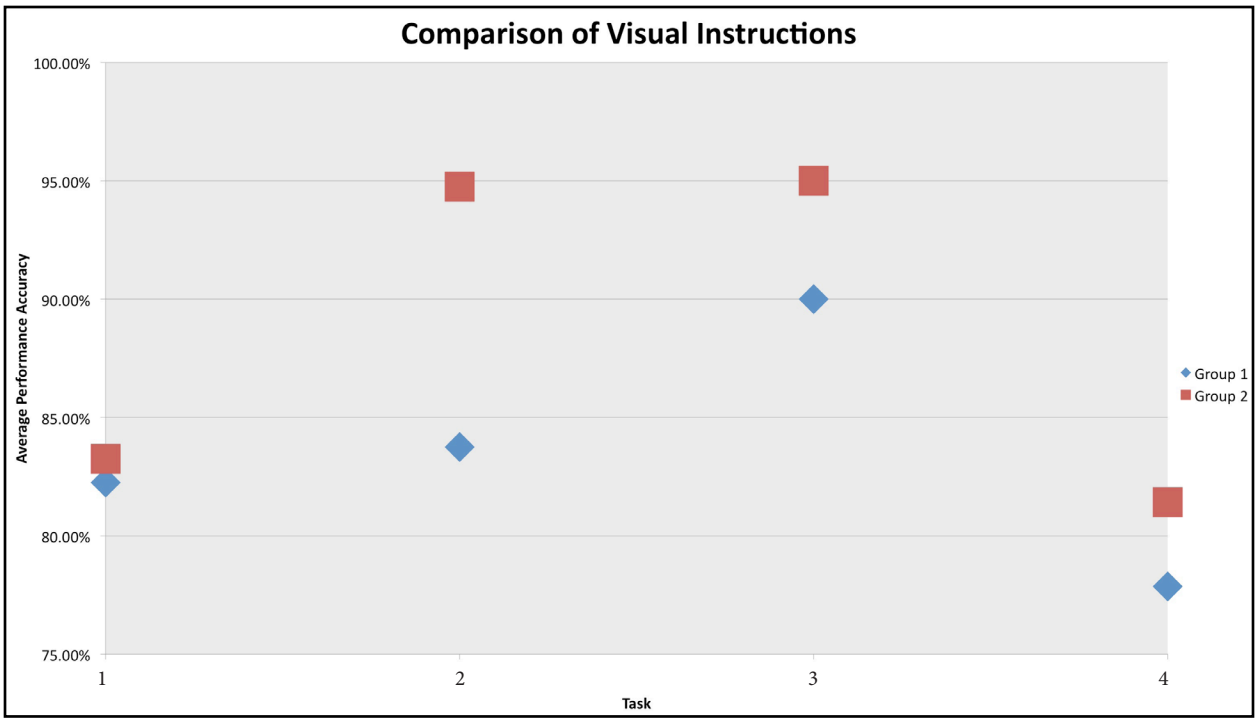

Chart 12: comparing the task performance of Group 1 and 2 when given visual instructions

Group 1	Group 2
(1) 82.25%	83.25%
(2) 83.75%	94.75%
(3) 90.00%	95.00%
(4) 77.86%	81.42%

Table 16: Comparing Performance of Visual Instructions

Overall, Group 2 performed better in its tasks when given visual instructions than Group 1, when comparing accuracy.

As can be seen from Chart 11 & 12, Group 2 performed with better accuracy than Group 1, whether it involved visual or verbal instructions. This led to the conclusion that verbal instructions by itself yields higher sucess more than visual instructions being provided prior to verbal instructions. This is because Group 1 involved the completion of tasks with visual instructions and then verbal, which performed worse than Group 2. They were given verbal instructions first, followed by visual.

Another conclusion is that providing visual instructions after verbal instructions increases success in the completion and accuracy of tasks. It can easily be seen from all the previous charts

and tables that subjects performed better when given visual instructions over verbal. However, a deeper conclusion was found when comparing the performance of verbal instructions and visual instructions to themselves by the groups the subjects were placed in. Charts 11 & 12 provide evidence that subjects performed better when given verbal instructions first as a basis. The last step involved a more in depth analysis involving statistical analysis, which will be explained in the next section.

Appendix B

Major: _____ Year in School: _____ Age: _____

Ethnicity: _____

Circle One: Native English Speaker Non-Native English Speaker

Please rate the difficulty of each task with 1 = very easy and 5 = very hard:

(A) Form Based Code Building Site Verbal Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(1) Form Based Code Building Site Visual Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(B) Form Based Code Building Form Verbal Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(2) Form Based Code Building Form Visual Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(C) Assembly Task Verbal Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(3) Assembly Task Visual Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(D) Origami Task Verbal Instruction Time: Grade:

1 2 3 4 5 Not Applicable

(4) Origami Task Visual Instruction Time: Grade:

1 2 3 4 5 Not Applicable

Appendix C

Task 1 - Visual					Profile					
Subject	Time	Time (sec)	Grade (4)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[5]:11.33	311	3	5	CRP	4	21	Caucasian	Yes	1
2	[3]:19.28	199	3	3.5	Pre-Engineering	1	19	Caucasian	Yes	1
3	[2]:17.68	138	2	4	Landscape Architecture	3	21	Caucasian	Yes	1
4	[5]:04.74	305	3	3	Architecture	5	22	Caucasian	Yes	1
5	[1]:27.18	87	4	2	Psychology	4	22	Caucasian	Yes	1
6	[4]:26.91	267	4	2	ECE - MASTERS	5	23	Asian	No	1
7	[1]:43.34	103	4	3	Psychology	1	18	Caucasian	Yes	1
8	[6]:09.74	370	3	4	Architecture	6	23	Caucasian	Yes	1
9	[6]:34.50	335	2	3	Exploration	1	18	Caucasian	Yes	1
10	[3]:30.80	211	4	3	Mechanical Engineering	1	18	Caucasian	Yes	1
11	[2]:21.76	142	4	3	Biochemistry	1	18	Pacific Islander	Yes	1
12	[3]:37.06	217	4	5	Actuarial Science	1	18	Caucasian	Yes	1
13	[2]:17.05	137	2	2	Communications	2	19	Caucasian	Yes	1
14	[5]:00.23	300	4	3	Electrical/Computer Engineering	1	18	Asian	Yes	1
15	[5]:18.31	318	2	1	CRP	5	23	Caucasian	Yes	2
16	[4]:04.36	244	4	4	Zoology	4	21	Caucasian	Yes	2
17	[2]:16.61	136	4	3	Political Science	4	22	Caucasian	Yes	2
18	[3]:30.01	210	4	1	Jazz Studies	3	20	Caucasian	Yes	2
19	[1]:31.98	92	3	3	CRP	3	23	Caucasian	Yes	2
20	[2]:47.10	167	4	2	Neuroscience	2	20	Caucasian	Yes	2
21	[5]:40.91	341	3	4	Biology	4	22	Caucasian	Yes	2
22	[3]:28.45	208	3.5	3	Chemical Engineering	1	19	Caucasian	Yes	2
23	[2]:52.73	173	1.5	3	Psychology	1	18	Caucasian	Yes	2
24	[3]:45.31	225	4	2	Industrial Design	2	20	Caucasian	Yes	2
25	[2]:00.11	120	4	2	Architecture	5	23	Caucasian	Yes	2
26	[3]:02.56	183	3	4	Exploration	1	18	Caucasian	Yes	2

Task A - Verbal					Profile					
Subject	Time	Time (sec)	Grade (4)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[5]:39.58	340	3	4	Architecture	4	22	Caucasian	Yes	1
2	[3]:16.31	196	0	4	Film Studies	5	23	Caucasian	Yes	1
3	[6]:32.45	392	2	3	Exploration	1	19	Asian	Yes	1
4	[2]:24.43	144	2	2	Human Development & Family Science	4	21	Caucasian	Yes	1
5	[6]:13.13	373	3	3	CRP	5	22	Hispanic	Yes	1
6	[4]:43.61	284	3	4	Areospace Engineering	4	21	Caucasian	Yes	1
7	[2]:40.45	160	1	3	CRP	4	21	Caucasian	No	1
8	[3]:43.15	223	2	3	Architecture - MASTERS	6	24	Asian	No	1
9	[3]:07.36	187	4	4	Exploration	1	19	Caucasian	Yes	1
10	[1]:55.37	115	4	1	Business	1	19	Asian	Yes	1
11	[2]:52.70	173	4	1	Exploration	1	19	Asian	Yes	1
12	[6]:03.02	362	4	3	Electrical Engineering	1	18	African American	Yes	1
13	[1]:38.05	98	3	3	Chemical Engineering	2	21	Asian	No	2
14	[1]:53.93	114	3	2	CRP	2	20	Caucasian	Yes	2
15	[2]:25.36	145	3.5	3	Chemical Engineering	1	18	Caucasian	Yes	2
16	[10]:31.93	632	4	4.5	Speech and Hearing Science	2	19	Caucasian	Yes	2
17	[3]:15.20	185	3	4	Aerospace Engineering	3	20	Caucasian	Yes	2
18	[3]:49.05	229	2	4	Music - MASTERS	6	24	Caucasian	Yes	2
19	[6]:37.20	397	3	3	History	1	19	Caucasian	Yes	2
20	[3]:57.20	237	1	4	Economics	1	26	Asian	No	2
21	[9]:51.83	592	3	5	Neuroscience	1	18	Hispanic	No	2
22	[7]:17.45	437	3	4	Computer Science Engineering	1	19	Caucasian	Yes	2
23	[2]:06.33	126	4	2	Engineering	1	19	Asian	Yes	2
24	[2]:56.00	176	3	3	Actuarial Science	1	19	Caucasian	Yes	2
25	[4]:55.03	295	2.5	3	Chemical Engineering	1	18	Caucasian	Yes	2
26	[6]:49.05	409	2	3	Mechanical Engineering	1	19	Asian	No	2

Task 2 - Visual					Profile					
Subject	Time	Time (sec)	Grade (4)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[1]:02.35	62	4	1	Film Studies	5	23	Caucasian	Yes	1
2	[0]:59.78	60	4	1	Landscape Architecture	3	21	Caucasian	Yes	1
3	[4]:44.41	284	2.5	3	Exploration	1	19	Asian	Yes	1
4	[2]:47.76	168	3	2	CRP	5	22	Hispanic	Yes	1
5	[1]:43.00	103	3	3	Areospace Engineering	4	21	Caucasian	Yes	1
6	[1]:48.98	109	4	1	Architecture - MASTERS	6	24	Asian	No	1
7	[0]:52.16	52	3	1	Psychology	1	18	Caucasian	Yes	1
8	[1]:53.96	114	4	3	Exploration	1	19	Caucasian	Yes	1
9	[1]:16.50	77	4	2	Exploration	1	19	Asian	Yes	1
10	[1]:45.90	106	4	3	Mechanical Engineering	1	18	Caucasian	Yes	1
11	[3]:10.30	190	2	3	Biochemistry	1	18	Pacific Islander	Yes	1
12	[2]:06.00	126	4	2	Business	1	19	Asian	Yes	1
13	[1]:23.40	83	2	3	Electrical Engineering	1	18	African American	Yes	1
14	[1]:19.66	80	4	1	CRP	5	23	Caucasian	Yes	2
15	[1]:07.15	67	4	2	Chemical Engineering	2	21	Asian	No	2
16	[1]:23.65	84	4	4	CRP	2	20	Caucasian	Yes	2
17	[2]:07.06	127	4	1	Chemical Engineering	1	18	Caucasian	Yes	2
18	[3]:33.18	213	4	2	Speech and Hearing Science	2	19	Caucasian	Yes	2
19	[0]:59.00	59	4	1	Aerospace Engineering	3	20	Caucasian	Yes	2
20	[1]:23.81	84	4	1	Music - MASTERS	6	24	Caucasian	Yes	2
21	[0]:55.25	55	3	1	Neuroscience	2	20	Caucasian	Yes	2
22	[1]:11.36	71	4	1	Biology	4	22	Caucasian	Yes	2
23	[4]:04.66	245	4	2	History	1	19	Caucasian	Yes	2
24	[0]:59.91	60	4	1	Exploration	1	18	Caucasian	Yes	2
25	[2]:59.30	179	3	1	Economics	1	26	Asian	No	2
26	[1]:32.56	93	4	2	Actuarial Science	1	19	Caucasian	Yes	2
27	[1]:42.70	103	3	3	Computer Science Engineering	1	19	Caucasian	Yes	2

Appendix C Continued

Task B - Verbal					Profile					
Subject	Time	Time (sec)	Grade (4)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[2]:07.14	127	4	2	Architecture	4	22	Caucasian	Yes	1
2	[0]:58.81	59	4	1	CRP	4	21	Caucasian	Yes	1
3	[1]:14.11	74	4	1	Pre-Engineering	1	19	Caucasian	Yes	1
4	[4]:17.78	258	3	2	Architecture	5	22	Caucasian	Yes	1
5	[1]:53.80	114	4	1	Human Development & Family Science	4	21	Caucasian	Yes	1
6	[0]:39.18	39	4	1	Psychology	4	22	Caucasian	Yes	1
7	[1]:57.43	117	4	1	CRP	4	21	Caucasian	No	1
8	[1]:08.53	69	4	1	ECE - MASTERS	5	23	Asian	No	1
9	[1]:35.48	95	4	1	Architecture	6	23	Caucasian	Yes	1
10	[1]:45.50	106	3	2	Exploration	1	18	Caucasian	Yes	1
11	[7]:05.60	425	3	5	Actuarial Science	1	18	Caucasian	Yes	1
12	[1]:32.46	92	2	1	Communications	2	19	Caucasian	Yes	1
13	[6]:39.04	399	2	5	Electrical/Computer Engineering	1	18	Asian	Yes	1
14	[1]:02.56	63	3	2	Zoology	4	21	Caucasian	Yes	2
15	[0]:40.25	40	3	2	Political Science	4	22	Caucasian	Yes	2
16	[2]:13.01	133	4	1	Jazz Studies	3	20	Caucasian	Yes	2
17	[1]:52.10	112	4	2	CRP	3	23	Caucasian	Yes	2
18	[1]:03.48	63	4	1	Chemical Engineering	1	19	Caucasian	Yes	2
19	[2]:16.11	136	4	3	Neuroscience	1	18	Hispanic	No	2
20	[2]:29.01	149	4	2	Engineering	1	19	Asian	Yes	2
21	[0]:53.48	53	4	1	Psychology	1	18	Caucasian	Yes	2
22	[0]:37.28	37	4	1	Chemical Engineering	1	18	Caucasian	Yes	2
23	[1]:05.20	65	4	1	Industrial Design	2	20	Caucasian	Yes	2
24	[0]:47.60	48	4	1	Architecture	5	23	Caucasian	Yes	2
25	[4]:23.81	264	4	2	Mechanical Engineering	1	19	Asian	No	2

Task 3 - Visual					Profile					
Subject	Time	Time (sec)	Grade (5)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[3]:37.46	217	4.5	2	Architecture	4	22	Caucasian	Yes	1
2	[3]:29.38	209	5	2	CRP	4	21	Caucasian	Yes	1
3	[2]:26.84	147	4.5	1	Film Studies	5	23	Caucasian	Yes	1
4	[3]:38.21	218	4.5	2	Pre-Engineering	1	19	Caucasian	Yes	1
5	[3]:05.58	186	4.5	1	Human Development & Family Science	4	21	Caucasian	Yes	1
6	[3]:10.48	190	4.5	2	Psychology	4	22	Caucasian	Yes	1
7	[3]:08.73	189	4	2	Areospace Engineering	4	21	Caucasian	Yes	1
8	[3]:57.33	237	4	2	Architecture - MASTERS	6	24	Asian	No	1
9	[3]:13.05	193	4	2	ECE - MASTERS	5	23	Asian	No	1
10	[2]:10.10	130	4	2	Exploration	1	19	Caucasian	Yes	1
11	[3]:25.06	205	5	1	Architecture	6	23	Caucasian	Yes	1
12	[4]:19.60	260	5	1	Electrical/Computer Engineering	1	18	Asian	Yes	1
13	[4]:15.35	255	5	2	Electrical Engineering	1	18	African American	Yes	1
14	[4]:06.51	247	4.5	3	Chemical Engineering	2	21	Asian	No	2
15	[3]:23.39	203	4	2	CRP	2	20	Caucasian	Yes	2
16	[2]:19.66	140	4	3	Music - MASTERS	6	24	Caucasian	Yes	2
17	[5]:56.31	356	4.5	1	History	1	19	Caucasian	Yes	2
18	[4]:04.25	244	5	1	Chemical Engineering	1	19	Caucasian	Yes	2
19	[6]:59.76	420	5	4	Neuroscience	1	18	Hispanic	No	2
20	[3]:07.05	187	5	2	Computer Science Engineering	1	19	Caucasian	Yes	2
21	[4]:18.18	358	5	3	Engineering	1	19	Asian	Yes	2
22	[3]:10.38	190	5	1	Psychology	1	18	Caucasian	Yes	2
23	[5]:22.00	322	5	2	Chemical Engineering	1	18	Caucasian	Yes	2
24	[2]:50.21	170	5	1	Architecture	5	23	Caucasian	Yes	2
25	[6]:57.43	417	5	1	Mechanical Engineering	1	19	Asian	No	2

Task C - Verbal					Profile					
Subject	Time	Time (sec)	Grade (5)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[4]:29.25	269	3.5	3	Landscape Architecture	3	21	Caucasian	Yes	1
2	[5]:24.85	325	4	2	Exploration	1	19	Asian	Yes	1
3	[2]:59.55	180	3.5	1	Architecture	5	22	Caucasian	Yes	1
4	[8]:00.55	481	3	4	CRP	5	22	Hispanic	Yes	1
5	[4]:29.35	269	1	2	CRP	4	21	Caucasian	No	1
6	[4]:45.71	285	4.5	2	Psychology	1	18	Caucasian	Yes	1
7	[8]:57.80	538	4	4	Exploration	1	18	Caucasian	Yes	1
8	[5]:33.00	333	3.5	4	Exploration	1	19	Asian	Yes	1
9	[3]:37.03	217	4.5	4	Biochemistry	1	18	Pacific Islander	Yes	1
10	[4]:11.42	251	4	3	Actuarial Science	1	18	Caucasian	Yes	1
11	[4]:35.08	275	4.5	2	Communications	2	19	Caucasian	Yes	1
12	[8]:01.03	481	4.5	3	Business	1	19	Asian	Yes	1
13	[3]:52.90	233	3	5	Mechanical Engineering	1	18	Caucasian	Yes	1
14	[5]:11.91	312	3.5	2	CRP	5	23	Caucasian	Yes	2
15	[4]:26.51	267	4	3	Zoology	4	21	Caucasian	Yes	2
16	[2]:28.11	148	3.5	3	Political Science	4	22	Caucasian	Yes	2
17	[4]:10.84	251	4.5	2	Chemical Engineering	1	18	Caucasian	Yes	2
18	[5]:33.78	334	4.5	3	Speech and Hearing Science	2	19	Caucasian	Yes	2
19	[3]:20.18	200	4.5	1	Jazz Studies	3	20	Caucasian	Yes	2
20	[3]:41.51	222	3.5	2	Aerospace Engineering	3	20	Caucasian	Yes	2
21	[2]:13.40	133	2	2	CRP	3	23	Caucasian	Yes	2
22	[4]:57.66	280	3.5	3	Neuroscience	2	20	Caucasian	Yes	2
23	[6]:23.51	384	4	4	Biology	4	22	Caucasian	Yes	2
24	[5]:43.25	343	4.5	3	Exploration	1	18	Caucasian	Yes	2
25	[3]:08.58	189	3.5	2	Actuarial Science	1	19	Caucasian	Yes	2
26	[2]:24.65	145	2	3	Industrial Design	2	20	Caucasian	Yes	2
27	[3]:09.53	190	0	3	Economics	1	26	Asian	No	2

Appendix C Continued

Task 4 - Visual					Profile					
Subject	Time	Time (sec)	Grade (7)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[9]:05.10	545	4	5	Architecture	4	22	Caucasian	Yes	1
2	[6]:57.89	418	5	3	Exploration	1	19	Asian	Yes	1
3	[6]:43.48	403	6.5	2	Architecture	5	22	Caucasian	Yes	1
4	[6]:01.85	362	5	5	Human Development & Family Science	4	21	Caucasian	Yes	1
5	[4]:14.08	254	5	4	CRP	5	22	Hispanic	Yes	1
6	[5]:01.10	301	4	4	CRP	4	21	Caucasian	No	1
7	[9]:31.40	571	7	3	Exploration	1	18	Caucasian	Yes	1
8	[3]:47.65	228	6.5	4	Actuarial Science	1	18	Caucasian	Yes	1
9	[5]:46.43	346	7	4	Communications	2	19	Caucasian	Yes	1
10	[2]:58.00	178	4	5	Business	1	19	Asian	Yes	1
11	[3]:41.07	221	6	3	Exploration	1	19	Asian	Yes	1
12	[6]:16.02	376	3	5	Zoology	4	21	Caucasian	Yes	2
13	[2]:57.36	177	7	4	Political Science	4	22	Caucasian	Yes	2
14	[6]:47.87	408	6	5	Chemical Engineering	1	18	Caucasian	Yes	2
15	[7]:28.87	449	7	3	Speech and Hearing Science	2	19	Caucasian	Yes	2
17	[3]:52.20	232	6.5	3	Aerospace Engineering	3	20	Caucasian	Yes	2
18	[2]:18.08	138	5	5	CRP	3	23	Caucasian	Yes	2
19	[7]:47.90	468	5	4	Engineering	1	19	Asian	Yes	2
20	[3]:54.05	234	3.5	2	Actuarial Science	1	19	Caucasian	Yes	2
21	[4]:44.51	285	7	2	Chemical Engineering	1	18	Caucasian	Yes	2
22	[5]:13.16	313	7	3	Industrial Design	2	20	Caucasian	Yes	2

Task D - Verbal					Profile					
Subject	Time	Time (sec)	Grade (7)	Rating	Major	Year in School	Age	Ethnicity	Native English Speaker	Group
1	[7]:46.33	466	5	5	CRP	4	21	Caucasian	Yes	1
2	[5]:20.89	321	4	5	Film Studies	5	23	Caucasian	Yes	1
3	[7]49.91	470	5	5	Pre-Engineering	1	19	Caucasian	Yes	1
4	[3]:02.60	183	4	4	Landscape Architecture	3	21	Caucasian	Yes	1
5	[3]:49.56	230	6	4	Psychology	4	22	Caucasian	Yes	1
6	[6]:02.03	362	4	5	Areospace Engineering	4	21	Caucasian	Yes	1
7	[7]:16.68	437	3	5	Architecture - MASTERS	6	24	Asian	No	1
8	[5]:13.43	313	2	4	ECE - MASTERS	5	23	Asian	No	1
9	[3]:57.33	237	2.5	5	Psychology	1	18	Caucasian	Yes	1
10	[2]:56.99	177	4	5	Exploration	1	19	Caucasian	Yes	1
11	[7]:13.01	433	3	5	Architecture	6	23	Caucasian	Yes	1
12	[9]:51.30	591	5.5	5	Mechanical Engineering	1	18	Caucasian	Yes	1
13	[6]:24.55	385	0	5	Electrical/Computer Engineering	1	18	Asian	Yes	1
14	[1]:33.98	94	3	5	Electrical Engineering	1	18	African American	Yes	1
15	[3]:35.57	216	.5/7	2	Biochemistry	1	18	Pacific Islander	Yes	1
16	[7]:04.97	425	4	3	CRP	5	23	Caucasian	Yes	2
17	[3]:14.28	194	4	5	Chemical Engineering	2	21	Asian	No	2
18	[3]:37.30	217	3.5	5	CRP	2	20	Caucasian	Yes	2
19	[3]:06.80	187	4	4	Music - MASTERS	6	24	Caucasian	Yes	2
20	[2]:44.68	165	2	4	Neuroscience	2	20	Caucasian	Yes	2
21	[6]:38.57	399	3	5	Biology	4	22	Caucasian	Yes	2
22	[6]:33.99	394	2.5	4	History	1	19	Caucasian	Yes	2
23	[2]:58.26	178	1	5	Chemical Engineering	1	19	Caucasian	Yes	2
24	[4]:50.46	290	4	5	Exploration	1	18	Caucasian	Yes	2
25	[5]:45.37	345	7	4	Economics	1	26	Asian	No	2
26	[19]:37.86	1178	6	5	Neuroscience	1	18	Hispanic	No	2
27	[3]:34.75	215	3.5	5	Psychology	1	18	Caucasian	Yes	2
28	[7]:28.71	449	5.5	4	Architecture	5	23	Caucasian	Yes	2
29	[4]:05.04	245	4	5	Computer Science Engineering	1	19	Caucasian	Yes	2

Appendix D

Average TIME	Task 1 & A	Task 2 & B	Task 3 & C	Task 4 & D
Visual	213.04	113.11	235.60	328.90
Verbal	270.04	125.48	179.07	337.79
Average GRADE	**Task 1 & A**	**Task 2 & B**	**Task 3 & C**	**Task 4 & D**
Visual	82.75%	89.25%	92.40%	79.57%
Verbal	69.25%	91.00%	68.60%	53.57%
Average RATING	**Task 1 & A**	**Task 2 & B**	**Task 3 & C**	**Task 4 & D**
Visual	2.98	1.89	1.84	3.71
Verbal	3.17	1.72	2.78	4.55

Table 17. Tables of the average times of completion, grade of accuracy, and self rating of difficulty split for each task, whether its visual or verbal.

Group	Time	Self Rating	Grade
Group 1 - Task 1	223	3.25	82.25%
Group 2 - Task 1	201.42	2.67	83.25%
Group 1 - Task A	245.75	2.92	66.75%
Group 2 - Task A	290.86	3.39	71.50%
Group 1 - Task 2	118	2.15	83.75%
Group 2 - Task 2	108.57	1.64	94.75%
Group 1 - Task B	151.85	1.85	86.50%
Group 2 - Task B	96.92	1.58	95.75%
Group 1 - Task 3	202.77	1.69	90.00%
Group 2 - Task 3	271.17	2	95.00%
Group 1 - Task C	318.23	3	66.66%
Group 2 - Task C	242.71	2.57	70.00%
Group 1 - Task 4	347.91	3.82	77.86%
Group 2 - Task 4	308	3.6	81.42%
Group 1 - Task D	335.64	4.79	52.00%
Group 2 - Task D	348.64	4.5	55.14%

Table 18. Table of the average times of completion, grade of accuracy, and self rating of difficulty split for each task, whether its visual or verbal and whether the subject belongs in Group 1 or Group 2.

Appendix E

Subject	Instruction	Task	Group	Condition	Trial	Time	Grade	Rating	Age	Sch_Year	Ethnicity	English S	Major
1	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	217	90.00%	2.00	22	4	Caucasian	Yes	Architecture
1	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	545	57.14%	5.00	22	4	Caucasian	Yes	Architecture
1	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	340	75.00%	4.00	22	4	Caucasian	Yes	Architecture
1	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	127	100.00%	2.00	22	4	Caucasian	Yes	Architecture
2	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	311	75.00%	5.00	21	4	Caucasian	Yes	CRP
2	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	217	100.00%	2.00	21	4	Caucasian	Yes	CRP
2	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	59	100.00%	1.00	21	4	Caucasian	Yes	CRP
2	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	466	71.43%	5.00	21	4	Caucasian	Yes	CRP
3	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	62	100.00%	1.00	23	5	Caucasian	Yes	Film Studies
3	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	147	90.00%	1.00	23	5	Caucasian	Yes	Film Studies
3	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	196	0.00%	4.00	23	5	Caucasian	Yes	Film Studies
3	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	321	57.14%	5.00	23	5	Caucasian	Yes	Film Studies
4	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	199	75.00%	3.50	19	1	Caucasian	Yes	Pre-Engineering
4	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	218	90.00%	2.00	19	1	Caucasian	Yes	Pre-Engineering
4	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	74	100.00%	1.00	19	1	Caucasian	Yes	Pre-Engineering
4	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	470	71.43%	5.00	19	1	Caucasian	Yes	Pre-Engineering
5	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	138	50.00%	4.00	21	3	Caucasian	Yes	Landscrape Architecture
5	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	60	100.00%	1.00	21	3	Caucasian	Yes	Landscrape Architecture
5	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	269	70.00%	3.00	21	3	Caucasian	Yes	Landscrape Architecture
5	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	183	57.14%	4.00	21	3	Caucasian	Yes	Landscrape Architecture
6	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	284	62.50%	3.00	19	1	Asian	Yes	Exploration
6	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	418	71.43%	3.00	19	1	Asian	Yes	Exploration
6	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	392	50.00%	3.00	19	1	Asian	Yes	Exploration
6	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	418	80.00%	2.00	19	1	Asian	Yes	Exploration
7	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	305	75.00%	3.00	22	5	Caucasian	Yes	Architecture
7	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	403	92.86%	2.00	22	5	Caucasian	Yes	Architecture
7	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	258	75.00%	2.00	22	5	Caucasian	Yes	Architecture
7	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	180	70.00%	1.00	22	5	Caucasian	Yes	Architecture
8	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	186	90.00%	1.00	21	4	Caucasian	Yes	Human Development & Family Science
8	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	362	71.43%	5.00	21	4	Caucasian	Yes	Human Development & Family Science
8	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	144	50.00%	2.00	21	4	Caucasian	Yes	Human Development & Family Science
8	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	114	100.00%	1.00	21	4	Caucasian	Yes	Human Development & Family Science
9	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	87	100.00%	2.00	22	4	Caucasian	Yes	Psychology
9	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	190	90.00%	2.00	22	4	Caucasian	Yes	Psychology
9	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	39	100.00%	1.00	22	4	Caucasian	Yes	Psychology
9	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	230	85.71%	4.00	22	4	Caucasian	Yes	Psychology
10	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	168	75.00%	2.00	22	5	Hispanic	Yes	CRP
10	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	254	71.43%	4.00	22	5	Hispanic	Yes	CRP
10	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	373	75.00%	3.00	22	5	Hispanic	Yes	CRP
10	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	481	60.00%	4.00	22	5	Hispanic	Yes	CRP
11	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	103	75.00%	3.00	21	4	Caucasian	Yes	Aerospace Engineering
11	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	189	100.00%	2.00	21	4	Caucasian	Yes	Aerospace Engineering
11	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	284	75.00%	4.00	21	4	Caucasian	Yes	Aerospace Engineering
11	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	362	57.14%	5.00	21	4	Caucasian	Yes	Aerospace Engineering
12	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	301	57.14%	4.00	21	4	Caucasian	No	CRP
12	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	160	25.00%	3.00	21	4	Caucasian	No	CRP
12	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	117	100.00%	1.00	21	4	Caucasian	No	CRP
12	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	269	20.00%	2.00	21	4	Caucasian	No	CRP
13	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	109	100.00%	1.00	24	6	Asian	No	Architecture - MASTERS
13	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	237	100.00%	2.00	24	6	Asian	No	Architecture - MASTERS
13	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	223	50.00%	3.00	24	6	Asian	No	Architecture - MASTERS
13	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	437	42.86%	5.00	24	6	Asian	No	Architecture - MASTERS
14	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	267	100.00%	2.00	23	5	Asian	No	ECE - MASTERS
14	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	193	80.00%	2.00	23	5	Asian	No	ECE - MASTERS
14	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	69	100.00%	1.00	23	5	Asian	No	ECE - MASTERS
14	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	313	28.57%	4.00	23	5	Asian	No	ECE - MASTERS
15	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	103	100.00%	3.00	18	1	Caucasian	Yes	Psychology
15	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	52	75.00%	1.00	18	1	Caucasian	Yes	Psychology
15	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	285	90.00%	2.00	18	1	Caucasian	Yes	Psychology
15	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	237	35.71%	5.00	18	1	Caucasian	Yes	Psychology
16	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	114	100.00%	3.00	19	1	Caucasian	Yes	Exploration
16	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	130	80.00%	2.00	19	1	Caucasian	Yes	Exploration
16	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	187	100.00%	4.00	19	1	Caucasian	Yes	Exploration
16	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	177	57.14%	5.00	19	1	Caucasian	Yes	Exploration
17	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	370	75.00%	4.00	23	6	Caucasian	Yes	Architecture
17	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	205	100.00%	1.00	23	6	Caucasian	Yes	Architecture
17	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	95	100.00%	1.00	23	6	Caucasian	Yes	Architecture
17	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	433	42.86%	5.00	23	6	Caucasian	Yes	Architecture
18	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	335	50.00%	3.00	18	1	Caucasian	Yes	Exploration
18	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	571	100.00%	3.00	18	1	Caucasian	Yes	Exploration
18	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	106	75.00%	2.00	18	1	Caucasian	Yes	Exploration
18	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	538	80.00%	4.00	18	1	Caucasian	Yes	Exploration
19	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	77	100.00%	2.00	19	1	Asian	Yes	Exploration
19	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	221	85.71%	3.00	19	1	Asian	Yes	Exploration
19	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	173	100.00%	1.00	19	1	Asian	Yes	Exploration
19	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	333	70.00%	4.00	19	1	Asian	Yes	Exploration
20	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	211	100.00%	3.00	18	1	Caucasian	Yes	Mechanical Engineering
20	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	106	100.00%	3.00	18	1	Caucasian	Yes	Mechanical Engineering
20	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	233	60.00%	5.00	18	1	Caucasian	Yes	Mechanical Engineering
20	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	591	78.57%	5.00	18	1	Caucasian	Yes	Mechanical Engineering
21	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	300	100.00%	3.00	18	1	Asian	Yes	Electrical/Computer Engineering
21	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	260	100.00%	1.00	18	1	Asian	Yes	Electrical/Computer Engineering
21	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	399	50.00%	5.00	18	1	Asian	Yes	Electrical/Computer Engineering
21	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	385	0.00%	5.00	18	1	Asian	Yes	Electrical/Computer Engineering
22	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	83	50.00%	3.00	18	1	African Am	Yes	Electrical Engineering
22	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr1	1	255	100.00%	2.00	18	1	African Am	Yes	Electrical Engineering
22	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	362	100.00%	3.00	18	1	African Am	Yes	Electrical Engineering
22	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	94	42.86%	5.00	18	1	African Am	Yes	Electrical Engineering
23	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	142	100.00%	3.00	18	1	Pacific Islar	Yes	Biochemistry
23	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	190	50.00%	3.00	18	1	Pacific Islar	Yes	Biochemistry
23	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	217	90.00%	4.00	18	1	Pacific Islar	Yes	Biochemistry
23	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr2	2	216	7.14%	2.00	18	1	Pacific Islar	Yes	Biochemistry
24	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	217	100.00%	5.00	18	1	Caucasian	Yes	Actuarial Science
24	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	228	92.86%	4.00	18	1	Caucasian	Yes	Actuarial Science
24	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	425	75.00%	5.00	18	1	Caucasian	Yes	Actuarial Science
24	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	251	80.00%	3.00	18	1	Caucasian	Yes	Actuarial Science
25	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr1	1	137	50.00%	2.00	19	2	Caucasian	Yes	Communications
25	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	346	100.00%	4.00	19	2	Caucasian	Yes	Communications
25	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr2	2	92	50.00%	1.00	19	2	Caucasian	Yes	Communications
25	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	275	90.00%	2.00	19	2	Caucasian	Yes	Communications
26	Visual	FormCode	Vis_1_St	In1Ta1Gr1Tr2	2	126	100.00%	2.00	19	1	Asian	Yes	Business
26	Visual	Assemble	Vis_1_St	In1Ta2Gr1Tr2	2	178	57.14%	5.00	19	1	Asian	Yes	Business
26	Verbal	FormCode	Vis_1_St	In2Ta1Gr1Tr1	1	115	100.00%	1.00	19	1	Asian	Yes	Business
26	Verbal	Assemble	Vis_1_St	In2Ta2Gr1Tr1	1	481	90.00%	3.00	19	1	Asian	Yes	Business
27	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	318	50.00%	1.00	23	5	Caucasian	Yes	CRP
27	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	80	100.00%	1.00	23	5	Caucasian	Yes	CRP

Appendix E Continued

Subject	Instruction	Task	Group	Condition	Trial	Time	Grade	Rating	Age	Sch_Year	Ethnicity	English S	Major
27	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	312	70.00%	2.00	23	5	Caucasian	Yes	CRP
27	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	425	57.14%	3.00	23	5	Caucasian	Yes	CRP
28	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	244	100.00%	4.00	21	4	Caucasian	Yes	Zoology
28	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	376	42.86%	5.00	21	4	Caucasian	Yes	Zoology
28	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	63	75.00%	2.00	21	4	Caucasian	Yes	Zoology
28	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	267	80.00%	3.00	21	4	Caucasian	Yes	Zoology
29	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	67	100.00%	2.00	21	2	Asian	No	Chemical Engineering
29	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	247	90.00%	3.00	21	2	Asian	No	Chemical Engineering
29	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	98	75.00%	3.00	21	2	Asian	No	Chemical Engineering
29	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	194	57.14%	5.00	21	2	Asian	No	Chemical Engineering
30	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	136	100.00%	3.00	22	4	Caucasian	Yes	Political Science
30	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	177	100.00%	4.00	22	4	Caucasian	Yes	Political Science
30	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	40	75.00%	2.00	22	4	Caucasian	Yes	Political Science
30	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	148	70.00%	3.00	22	4	Caucasian	Yes	Political Science
31	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	84	100.00%	4.00	20	2	Caucasian	Yes	CRP
31	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	203	80.00%	2.00	20	2	Caucasian	Yes	CRP
31	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	114	75.00%	2.00	20	2	Caucasian	Yes	CRP
31	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	217	50.00%	5.00	20	2	Caucasian	Yes	CRP
32	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	127	100.00%	1.00	18	1	Caucasian	Yes	Chemical Engineering
32	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	408	85.71%	5.00	18	1	Caucasian	Yes	Chemical Engineering
32	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	145	85.00%	3.00	18	1	Caucasian	Yes	Chemical Engineering
32	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	251	90.00%	2.00	18	1	Caucasian	Yes	Chemical Engineering
33	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	213	100.00%	2.00	19	2	Caucasian	Yes	Speech and Hearing Science
33	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	449	100.00%	3.00	19	2	Caucasian	Yes	Speech and Hearing Science
33	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	632	100.00%	4.50	19	2	Caucasian	Yes	Speech and Hearing Science
33	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	334	90.00%	3.00	19	2	Caucasian	Yes	Speech and Hearing Science
34	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	210	100.00%	1.00	20	3	Caucasian	Yes	Jazz Studies
34	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	735	92.86%	4.00	20	3	Caucasian	Yes	Jazz Studies
34	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	133	100.00%	1.00	20	3	Caucasian	Yes	Jazz Studies
34	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	200	90.00%	1.00	20	3	Caucasian	Yes	Jazz Studies
35	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	59	100.00%	1.00	20	3	Caucasian	Yes	Aerospace Engineering
35	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	232	92.86%	3.00	20	3	Caucasian	Yes	Aerospace Engineering
35	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	185	75.00%	4.00	20	3	Caucasian	Yes	Aerospace Engineering
35	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	222	70.00%	2.00	20	3	Caucasian	Yes	Aerospace Engineering
36	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	92	75.00%	3.00	23	3	Caucasian	Yes	CRP
36	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	138	71.43%	5.00	23	3	Caucasian	Yes	CRP
36	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	112	100.00%	2.00	23	3	Caucasian	Yes	CRP
36	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	133	40.00%	2.00	23	3	Caucasian	Yes	CRP
37	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	84	100.00%	1.00	24	6	Caucasian	Yes	Music - MASTERS
37	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	140	80.00%	3.00	24	6	Caucasian	Yes	Music - MASTERS
37	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	229	50.00%	4.00	24	6	Caucasian	Yes	Music - MASTERS
37	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	187	57.14%	4.00	24	6	Caucasian	Yes	Music - MASTERS
38	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	167	100.00%	2.00	20	2	Caucasian	Yes	Neuroscience
38	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	55	75.00%	1.00	20	2	Caucasian	Yes	Neuroscience
38	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	280	70.00%	3.00	20	2	Caucasian	Yes	Neuroscience
38	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	165	28.57%	4.00	20	2	Caucasian	Yes	Neuroscience
39	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	341	75.00%	4.00	22	4	Caucasian	Yes	Biology
39	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	71	100.00%	1.00	22	4	Caucasian	Yes	Biology
39	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	384	80.00%	4.00	22	4	Caucasian	Yes	Biology
39	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	399	42.86%	5.00	22	4	Caucasian	Yes	Biology
40	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	245	100.00%	2.00	19	1	Caucasian	Yes	History
40	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	356	90.00%	1.00	19	1	Caucasian	Yes	History
40	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	397	75.00%	3.00	19	1	Caucasian	Yes	History
40	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	394	35.71%	4.00	19	1	Caucasian	Yes	History
41	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	208	87.50%	3.00	19	1	Caucasian	Yes	Chemical Engineering
41	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	244	100.00%	1.00	19	1	Caucasian	Yes	Chemical Engineering
41	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	63	100.00%	1.00	19	1	Caucasian	Yes	Chemical Engineering
41	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	178	14.29%	5.00	19	1	Caucasian	Yes	Chemical Engineering
42	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	183	75.00%	4.00	18	1	Caucasian	Yes	Exploration
42	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	60	100.00%	1.00	18	1	Caucasian	Yes	Exploration
42	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	343	90.00%	3.00	18	1	Caucasian	Yes	Exploration
42	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	290	57.14%	5.00	18	1	Caucasian	Yes	Exploration
43	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	179	75.00%	1.00	26	1	Asian	No	Economics
43	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	237	25.00%	4.00	26	1	Asian	No	Economics
43	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	190	0.00%	3.00	26	1	Asian	No	Economics
43	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	345	100.00%	4.00	26	1	Asian	No	Economics
44	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	420	100.00%	4.00	18	1	Hispanic	No	Neuroscience
44	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	592	75.00%	5.00	18	1	Hispanic	No	Neuroscience
44	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	136	100.00%	3.00	18	1	Hispanic	No	Neuroscience
44	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	1178	85.71%	5.00	18	1	Hispanic	No	Neuroscience
45	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	103	75.00%	3.00	19	1	Caucasian	Yes	Computer Science Engineering
45	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	187	100.00%	2.00	19	1	Caucasian	Yes	Computer Science Engineering
45	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	437	75.00%	4.00	19	1	Caucasian	Yes	Computer Science Engineering
45	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	245	57.14%	5.00	19	1	Caucasian	Yes	Computer Science Engineering
46	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	358	100.00%	3.00	19	1	Asian	Yes	Engineering
46	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	468	71.43%	4.00	19	1	Asian	Yes	Engineering
46	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	126	100.00%	2.00	19	1	Asian	Yes	Engineering
46	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	149	100.00%	2.00	19	1	Asian	Yes	Engineering
47	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	417	100.00%	1.00	19	1	Asian	No	Mechanical Engineering
47	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	760	85.71%	3.00	19	1	Asian	No	Mechanical Engineering
47	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	409	50.00%	3.00	19	1	Asian	No	Mechanical Engineering
47	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	264	100.00%	2.00	19	1	Asian	No	Mechanical Engineering
48	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr2	2	93	100.00%	2.00	19	1	Caucasian	Yes	Actuarial Science
48	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	234	50.00%	2.00	19	1	Caucasian	Yes	Actuarial Science
48	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	176	75.00%	3.00	19	1	Caucasian	Yes	Actuarial Science
48	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	189	70.00%	2.00	19	1	Caucasian	Yes	Actuarial Science
49	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	173	37.50%	3.00	18	1	Caucasian	Yes	Psychology
49	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	190	100.00%	1.00	18	1	Caucasian	Yes	Psychology
49	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	53	100.00%	1.00	18	1	Caucasian	Yes	Psychology
49	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	215	50.00%	5.00	18	1	Caucasian	Yes	Psychology
50	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	322	100.00%	2.00	18	1	Caucasian	Yes	Chemical Engineering
50	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	285	100.00%	2.00	18	1	Caucasian	Yes	Chemical Engineering
50	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr1	1	295	62.50%	3.00	18	1	Caucasian	Yes	Chemical Engineering
50	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	37	100.00%	1.00	18	1	Caucasian	Yes	Chemical Engineering
51	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	225	100.00%	2.00	20	2	Caucasian	Yes	Industrial Design
51	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr2	2	313	100.00%	3.00	20	2	Caucasian	Yes	Industrial Design
51	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	65	100.00%	1.00	20	2	Caucasian	Yes	Industrial Design
51	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr1	1	145	40.00%	3.00	20	2	Caucasian	Yes	Industrial Design
52	Visual	FormCode	Verb_1_St	In1Ta1Gr2Tr1	1	120	100.00%	2.00	23	5	Caucasian	Yes	Architecture
52	Visual	Assemble	Verb_1_St	In1Ta2Gr2Tr1	1	170	100.00%	1.00	23	5	Caucasian	Yes	Architecture
52	Verbal	FormCode	Verb_1_St	In2Ta1Gr2Tr2	2	48	100.00%	1.00	23	5	Caucasian	Yes	Architecture
52	Verbal	Assemble	Verb_1_St	In2Ta2Gr2Tr2	2	449	78.57%	4.00	23	5	Caucasian	Yes	Architecture

Appendix E Continued

In excel, the data was listed by subjects, as can be seen in Appendix C. Measurements for each task were listed in the same row. To find correlation using statistical analysis, all the data had to be rearranged so that it was listed by task with its corresponding information. Thus, each subject's information took up 4 rows because of the 4 tasks they had to complete instead of being listed all together in 1 row.

The tasks with visual instructions kept their number labels, 1-4. However for statistical analysis, the tasks with the verbal instructions were converted from letters to numbers. Thus A became 5, B became 6, C became 7, and D became 8. New columns were created for Instruction, Task, Trial and Group. Instruction stood for whether the subject had visual or verbal instructions for that particular task. Task was the kind of task the subject had to perform, whether it was form based code or assembly. Task 1, 5, 2, 6 were labeled form based code and Task 3, 7, 4, 8 were labeled as assembly.

Overall, the task where the subjects had to create a building parcel outline based on form based codes, also known as set backs, had 26 subjects who performed the task with visual instructions and 26 subjects with verbal instructions. The task where the subjects had to create a unit structure based on form based codes had 27 subjects who performed the task with visual instructions and 25 subjects with verbal instructions. The first assembly task, which required the subjects to create an open bottom box, had 25 subjects who performed the task with visual instructions and 27 subjects with verbal instructions. The other assembly task, which required the subjects to fold an origami t-shirt, had 23 subjects who performed the task with visual instructions and 29 subjects with verbal instructions.

Trial stood for the type of task to distinguish between the 2 form based codes and 2 assembly tasks. The form based code that dealt with set backs and the assembly of the open bottom box was recoded as 1, while the other form based code that dealt with height and the origami was recoded as 2. The column Group stood for the order in which the subjects performed their task, whether they completed tasks with visual instructions first (1) or with verbal instructions first (2).

Lastly, all these were listed under the column Condition in shorthand. For example, In1Ta2Gr1Tr1 meant that this task had visual instructions (In1), the task was an assembly one (Ta2), the subject belonged in Group 1 who had visual instructions first (Gr1) and the task required the subject to assemble an open bottom box (Tr1). In total, there were 16 different conditions. All the data for time, grade, and rating were rearranged to fit under these new columns.